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Return on Investment— A Guide to Management Decisions

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Examples of the practical use of return on investment in the direction of improving divisional operating performance are not lacking in this paper, presented first at the Eastern States Regional Cost Conference in March, which also tackles the problem of what investment base to use from a company viewpoint and how to divide it to serve equally well for units within the company. The latter portion of the article emphasizes the use of prospective return on investment to facilitate planning of operations and capital investments.

SINCE THE PURPOSE of any private business operations is to produce profits, the basis for measuring profits is a matter of some importance. I believe there can be no argument that the only final guage of profitability over the long-term is the relationship of the profits to the investment required to produce them, that is, return on investment. This is certainly the basis of measurement on which investors and creditors rely. And it obviously does not come as news to the chief executive of any corporation who must face a board of directors from time to time.

Yet the most commonly used basis for measuring the profit rate of a business has been the profit margin, that is, the ratio of profits to sales. I believe it will be agreed that operating managers, at least those below the top management, have been principally concerned with profit margins and relatively unconcerned with return on investment. This is, perhaps, natural, in that operating managers generally have not been concerned with the acquisition of capital. Therefore, they have not been inclined to include it as a consideration in the measurement of profits. This has produced the anomalous situation in which those who supply the money for a business are expecting a result measured on

one basis, while those who employ the money are striving for a result measured on another.

This can result in serious misplanning. A failure on the part of operating managements to relate volume and profit performance to the capital required to produce it can easily result in excessive plant investment and abnormally high inventories. Also, in cases in which several lines of product are produced by the same company, the emphasis given the various lines can be badly planned if margin constitutes the only basis of measurement.

Investment Base Used In Calculating Return

Before we go much further in this discussion, it will be well to define the investment base used in computing the return ratio. There are several ways in which return can be stated. Perhaps the one most commonly thought of is return on net worth. This, obviously, is the return in which the investor is interested, since it represents the return on his investment. But return on net worth as a device for measuring operating performance is not generally useful, particularly if some of the capital is supplied by loan.

We might then look at return on net resources, considering as the base the aggregate of the long-term debt and the stockholders' equity. Here again, the picture is not complete, because of funds represented by short-term liabilities. The logical step seems to be to turn to the other side of the balance sheet and consider total assets as the base against which profits might be computed. Since the operating managers of the several units of a company have little control over the sources of outside capital, it seems logical that the base to be used in the measurement of their performance would be the total of the assets under their direction, regardless of the source from which the funds were derived. This base for measurement of return also squares best with the responsibility assigned to operating managers for the profitable employment of the assets entrusted to them. It has the further advantage of stating performance in a manner which lends readily to comparison with that of other operating divisions or competitive companies. Therefore, for purposes of this discussion, I will assume that total assets constitutes an acceptable investment base.

A question—and a controversial one—is whether total assets, as used as the base for calculating return, should include fixed assets at the gross figure or net of depreciation. The evidence seems to be that most companies measuring return on assets, include fixed assets at gross value, that is, original book value. In my company, where comparisons are made between operating divisions and between competitor companies, we follow this practice as a means of injecting

a rough adjustment factor. It provides some equalization of facility values of the different divisions or companies—equalization between those with old plants built at relatively low cost and those with new plants built at high cost.

By dealing with all plant values at gross, the distortion arising in asset base is somewhat reduced. I concede that the practice may have the effect of penalizing the newer plants for which the asset values are stated in dollars of considerably less value than those of the older plants. On the other hand, in theory at least, the new facilities are relatively more efficient than the old. Whether you value the fixed asset content at gross or net is probably a matter which can be decided only upon examination of the situation in your own company. In our case, as stated above, we use the gross figure. A number of other companies follow this practice, possibly because it seems to represent the more useful alternative.

Return on Investment—and Divisional Operation

So far we have discussed some of the questions involved in the selection of the investment base and not the difficulties involved in segregating the overall assets to the various divisions or product groups of the company. In multi-product or multi-plant situations, these difficulties have probably presented the greatest obstacle in employing the return on investment concept. Obviously, the effectiveness of using return on assets as a device for measuring the operating performance of any unit of the company depends largely on the accuracy with which the assets applying to that unit can be stated. There can be no confidence in the return ratio if the assets base is not valid. The best conceived plan that uses return on investment as an operating guide will be wrecked if the means of developing the asset base are not carefully worked out. The problems involved here will depend largely upon the extent to which the accounts, both income and asset, have been decentralized to correspond with the decentralization of operating responsibility.

In Westinghouse, we have gone most of the way toward decentralization and our accounting operations are decentralized accordingly. Thus, for Division A, the division manager is completely responsible for the profitable management of the assets of the division and the accounting manager of Division A maintains the complete books of account for the division. He prepares income statements and balance sheets in very much the same manner as the chief accountant of an independent company would. There are a few special rules to this game, as we play it, which I will briefly mention. Among these the first to be noted are that decentralized operating divisions do not actually carry in their bank

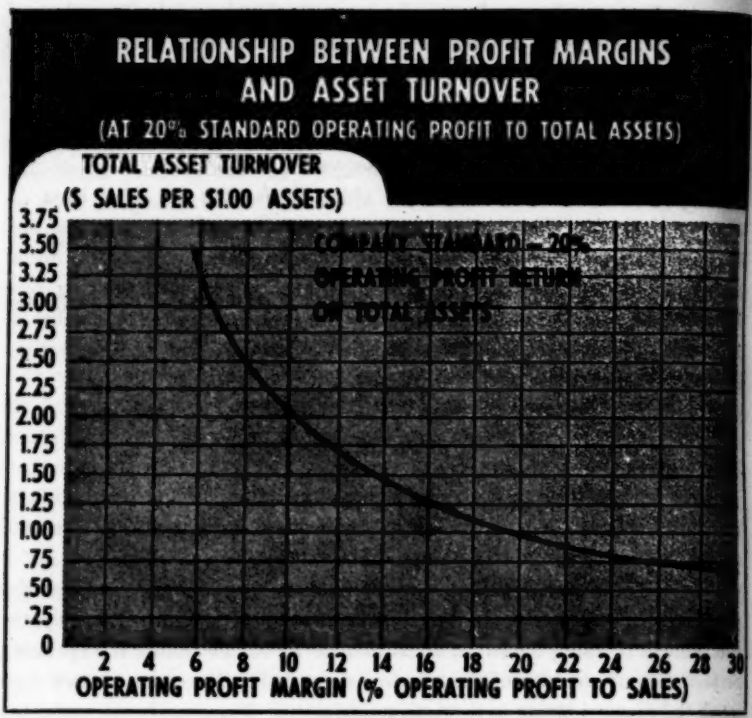


EXHIBIT 1

accounts the cash figures appearing on their balance sheets, nor do they, in all cases, have their accounts receivable on their own books. These amounts can usually be determined by formula in a manner reasonably representative of the balances required to support the volume of business which they are doing.

The simplest description of our method is that we have theoretically capitalized each division. In effect, each division is established as a separate financial entity, so that the balance in its cash account is determined by the flow of income and outgo. Thus, its hypothetical cash account reacts to the same forces as those affecting a separate company. It is increased by net earnings, by depreciation, by loans from the corporation, or by reductions in other working capital accounts. On the other hand, it is decreased by losses, by "dividends" paid to the corporation based on the capitalization of the division, by repayment of loans, or by increases in other fixed asset or working capital accounts.

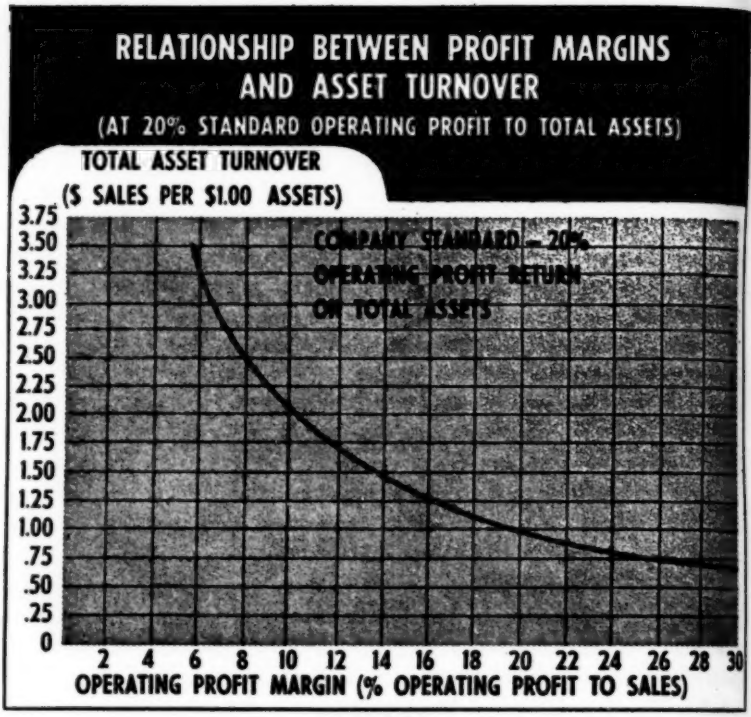
In other words, a relationship is established between the operating divisions

and the corporation in which the corporation is in the position of stockholder and, in some cases, that of creditor. It is still necessary, of course, to set minimums below which the hypothetical cash accounts of the divisions are not permitted to fall. Under this system, there remains a small residue of assets unallocated to the operating divisions but the amount of this residue has not been significant.

Some people feel that this practice of theoretically capitalizing the operating divisions assures a more realistic "cash" account and consequently a more valid total asset base for use in calculating return on assets. They also feel that it helps create in the divisions an attitude of entrepreneurship which would otherwise not exist. I believe the practice does have these advantages but it also possesses an artificiality in that there is, of course, no "market price" against which the earnings and "dividends" of the divisions can be measured. Return on assets, however, rather than "dividend" record, is still the prime measure, and the procedure involving theoretical capitalization, "dividends," and "loans" is justified if it helps produce a more valid total assets base.

If the company is a multi-plant or multi-product one, it may find that a shift to the return on investment concept of measuring performance may require some rather fundamental internal policy changes. One example of this is in the matter of interdivisional shipments, e.g., castings from the foundry division which may go into the product of several other divisions. To cite Westinghouse experience again, it was long our practice to transfer such shipments at cost. We let the profit element, if any, be reflected in the operating statement of the divisions making the ultimate sale to the customer. With the shift to return on investment as the measure of profits, it became obvious that the foundry manager, having no profit, would soon be looking for a new job. On the other hand, the assembly divisions were getting credit for profit produced by assets not charged to their operation.

For this and other reasons, we adopted a policy under which these interunit transactions would be handled on a competitive price basis. This establishes a supplier-customer relationship, in which the supplying division has to be competitive in all respects with outside suppliers. The customer has the right to place his business elsewhere if the supplying division does not measure up to competition. This has had some rather "eye-opening" results—all to the good. Some rather complicated accounting is required at the corporate level to eliminate interunit sales, to see that profit for the corporation is reported when the ultimate sale is made, and to assure that inventories are properly valued. But it is no more complex than the accounting required on the former transfer-at-cost basis.



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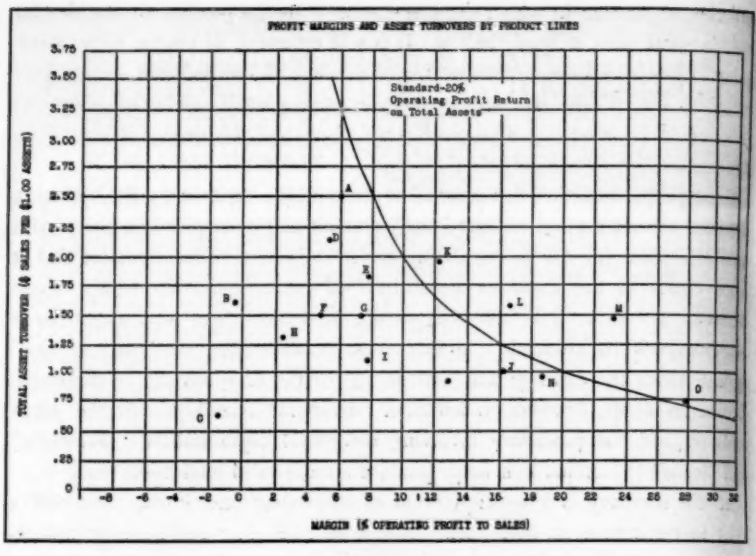

EXHIBIT 2

Return on Investment As An Operating Guide

These and many other problems are involved in establishing reports which will accurately associate sales and profits with the assets required to produce them. Let us assume that the accounting techniques are available to state the sales, profits and corresponding assets of a given operating unit. We will now turn to the process of measurement. The use of return on assets as a prime device for measuring and improving an operation will be enhanced if its determining factors are examined. The basic return-on-assets equation possesses a significance often overlooked because it is so elementary and obvious. It may be stated as follows:

Return on assets = Profit margin x Turnover
or more specifically:

$$\text{\% Profit to total assets} = \frac{\text{Profit}}{\text{Sales billed}} \times \frac{\text{Sales billed}}{\text{Total assets}}$$

Sales, profits and assets then become the three factors in the business equation—the eternal triangle of business. Sound planning and successful operation must point toward the optimum combination of these three factors to produce the best return on investment.

Obviously, the combination will and should vary depending upon the char-

acter of the product. Heavy apparatus, tailor-made to the customer's specifications and requiring long lead times, will generally require relatively more assets but should produce a higher margin. On the other hand, mass production of highly competitive consumer goods, should be planned for high turnover, because competition will not permit such lines to show a large margin. It follows, therefore, that, in multi-product companies, where the types of operations differ among products, goals and standards for turnover and margin cannot, in all cases, be uniform. The standards must reflect the fact that, because of inherent characteristics, product lines will and should vary in performance with respect to margin and turnover.

The relationship can be converted to concrete, though flexible, terms as illustrated in Exhibit 1. The chart shows graphically the combinations of profit margin and asset turnover which must be achieved to produce a 20 per cent return on assets. I am using the term "margin" for this purpose as meaning "per cent operating profit to sales billed." As will be seen, margin appears on the horizontal scale, turnover on the vertical. For instance, with a turnover of one, a margin of 20 per cent will be required to produce the 20 per cent return on assets. With a turnover of 1.5, a margin of 13.3 would be required. With a turnover of 2, a margin of 10 per cent would do the trick, and so on.

In a multi-product situation, the expression of return on investment in terms of its two factors, margin and turnover, not only has the advantage of flexibility in appraising profit performance—it also offers an approach by which performance can be analyzed for improvement. Thus top management can easily compare the company's performance with competitors (where published figures are available) and divisional or product managements can make similar comparisons with other divisions and products of the company, and with specialized competitors in comparable lines of business.

Two Cases Relating to Divisional Operations

This process can be exemplified by reference to two of the hypothetical divisions (or product lines) of an imaginary company illustrated on Exhibit 2. For one example, a look at Division A will be revealing. This division has a substandard asset return performance. (This is measured by the linear distance from the dot plotted for Division A and the curve representing the company standard, which in this case is a 20 per cent operating profit return on assets). In considering how it can work toward a more satisfactory return, the division manager sees that, in comparison with the other divisions, his asset turnover performance is the best but his margin, at only 6 per cent, is below the average.

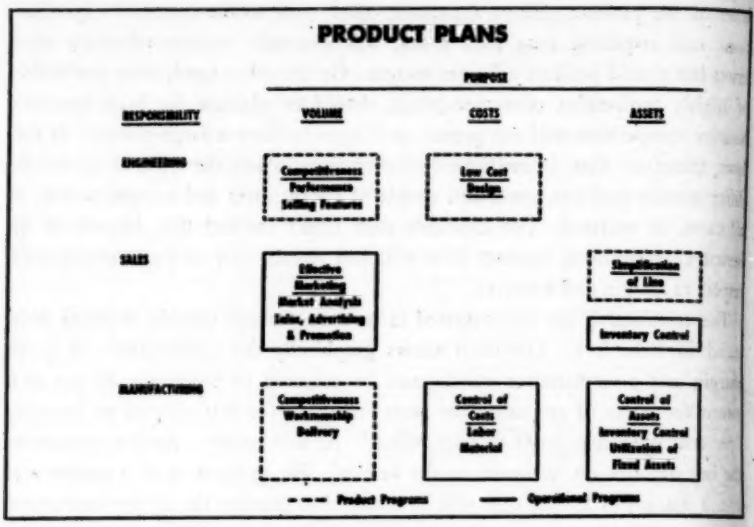

EXHIBIT 3

He is particularly impressed by the fact that Division K, with operating and product characteristics very similar to his own, produces a return in excess of the company standard. He sees also that this is achieved by twice as favorable a margin performance, in spite of a less favorable rate of asset turnover. He decides, therefore, that, in his long range planning, he will approach the problem of margin by attacking manufacturing costs and operating expenses. He realizes his advantage in a better rate of asset turnover. He decides to set his margin goal to equal that of Division K, i.e., 12 per cent, at the same time sustaining his turnover rate which, if achieved, would result in a better asset return ratio than the other division's current performance. Division J supplies a second example. The manager of Division J, with a substandard profit return, compares his performance with that of Division L. He knows it is essentially a similar type of operation and notices that the two divisions enjoy almost identical margins. However, his over-all result is depressed almost entirely by a lower asset turnover (at a rate of 1.00 compared to 1.60 for Division L). By further analysis, he finds out that his deficiency stems almost entirely from the relative inventory turnovers of the two divisions. This leads the manager of Division J into a comprehensive study of inventory levels and controls. From this he concludes that his inventory excess is primarily the result of two things:

1. A number of low-profit items which, in the aggregate, constitute a considerable portion of his finished product inventories but a very small percentage of his sales.
2. A number of profitable but relatively slow-moving items which are stocked in all of his field locations.

As a result of this survey, he sets his long-range goal to increase his asset turnover from 1.00 to 1.25 and to aim toward a small improvement in margin from 16.0 to 17. If this is achieved, it will put his division well over the asset return standard and well over the current performance of Division L. He plans to attain the improvement in asset turnover through increased turnover of inventories, by "weeding" his product lines of the items which are spoiling his profit return and by consolidating field stocks of slow-selling items.

Programming the Profit Goals

If the reader will subscribe to the idea that profit performance can be diagnosed more readily by examining the business in terms of both margin and turnover, let me move a step further into planning the operation for improved return on investment performance. Here, sound planning calls for establishment of long-range volume and profit objectives for the business as a whole and for each product line. Such long-term goals would usually be established for share of market, dollar sales volume, profits in dollars, and in terms of return on assets. These long-range performance goals may be little more than expressions of intent, but they will at least provide a target on which the sights can be fixed.

The attainment of the objectives will require the development of supporting programs—that is, specific, scheduled plans of action designed to improve the performance of each line of product from its present level to that stated in the long-range objectives. If return on investment has been established as the key objective and if it has been expressed in terms of specific profit margin and asset turnover goals for each product line, it becomes apparent that the marketing, engineering, and manufacturing programs in support of these objectives must necessarily be directed at one of the following:

1. To increase volume.
2. To increase margin by reducing the cost ratios.
3. To minimize assets in relation to volume.

If performance goals with respect to each of these three factors have been established, the gap between present performance and the goal can be quantitatively expressed for each factor. With the profit-improvement goal ex-

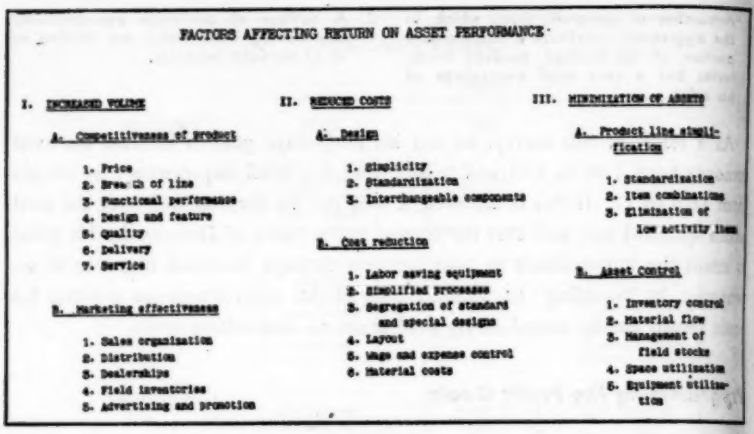

EXHIBIT 4

pressed in these definite terms, actions necessary to close the gap can be planned with increased focus. Obviously, all of these sources of improved performance are interrelated in their effect upon each other. Further, the coordinated activity of the three main functions—marketing, engineering, and manufacturing—is generally necessary to the accomplishment of any one of the three purposes mentioned, with respect to the product line in question. The block chart, Exhibit 3, shows the relationship of the principal factors of performance, by purpose. Each is identified with the functional responsibility for it. This portrayal oversimplifies the interrelationships involved but may serve to show how programs can be aimed at one of the three means by which performance can be improved.

I think that the sales, engineering, and manufacturing programs developed in support of the profit improvement plan will be materially improved in focus and in timing if each one is consciously identified with one of these three methods of improving the return on investment. For instance, referring to the chart, the engineering product development funds available for the year might be spent with greater impact if the projects in the program are identified as between those aimed at improving the competitiveness of the product and those intended to reduce its cost. If the particular problem of the product line is the attainment of greater volume, it is possible that cost reduction projects should be temporarily deferred so that the efforts of all available engineering manpower can be directed at the purpose of improving the customer acceptability of the product.

There is another advantage of working from the basic asset return equation in the planning of improved performance. If specific programs are aimed to one of the three elements of the equation, it becomes easier to evaluate their impact on the overall performance, thus assuring that the programs are closely meshed to the performance objectives they are designed to support. Exhibit 4 is an illustrative list of factors to be analyzed by the functional heads in connection with each of the several possible sources of improved profit performance. It will be noticed that these factors are listed under headings corresponding to the three elements of the return-on-investment equation—volume, costs, and assets.

A technique in planning for profit improvement might take this form: (1) define quantitatively the gap which exists, with respect to each of three elements, between performance at present and that represented by the long-term objective, (2) examine each of the detailed factors listed to define the problem, if any, which exists, (3) formulate a specific, scheduled program of action for each, and then (4) translate the planned results of each program in terms of effect upon the income and assets accounts. This is illustrated generally in Exhibit 5.

In this example the improvement in before-tax profit is programmed at $140,000, with $50,000 derived from increased volume and $90,000 from cost reductions, thus raising the profit margin from 10 per cent to 20 per cent. The asset base is projected at the same amount as at present, with a $100,000 reduction of inventories programmed to offset an $80,000 increase in equipment for cost reductions and a $20,000 increase in other working capital. Thus, the asset turnover at the higher rate of projected sales is increased from 1. to 1.2 times. This, combined with the improved profit margin, increases the before-tax return on assets from 10 per cent to 24 per cent.

This seemingly tedious process of programming the profit improvement of each line in terms of the three elements in the return on investment equation is not necessarily as painful as might appear at first thought. Presumably, if the company is healthy, most of the lines are already "on the beam" and existing plans will be sufficient to keep them that way. But for those lines which are "sick," the approach offers a means of diagnosis.

Decisions on Capital Investments

From the process which I have attempted to describe, there should result specific programs for marketing, engineering development, and manufacturing. I would like to discuss more specifically one area of such programs—that re-

EFFECT OF PLANNED PROGRAMS

	PRESENT $	PRESENT %	CHANGE BY VOLUME $	CHANGE BY COST REDUCTION $	ASSET CURTAILMENT $	FUTURE $	FUTURE %
PROFITS							
Sales billed	1,000,000	100.0	+200,000	-	-	1,200,000	100.0
Manufacturing cost	770,000	77.0	+140,000	-88,000	-	822,000	68.5
Distribution expense	50,000	5.0	+ 4,000	-	-	54,000	4.5
Engineering expense	50,000	5.0	+ 6,000	-	-	56,000	4.7
Administrative expense	30,000	3.0	-	- 2,000	-	28,000	2.3
Profit (before taxes)	100,000	10.0	+ 50,000	+90,000	-	240,000	20.0
* per cent to sales billed							
ASSETS							
Inventory	500,000		-	-	-100,000	400,000	
Other Working Capital	200,000		+ 20,000	-	-	220,000	
Fixed Assets	300,000		-	+80,000	-	380,000	
Total	1,000,000		+ 20,000	+80,000	-100,000	1,000,000	
RETURN ON ASSETS							
Profit Margin (%)		10.0					20.0
Asset Turnover (times)		1.00					1.20
Return on Assets (%)		10.0					24.00

EXHIBIT 5

lating to capital investment in fixed assets. Decisions on plant and facility additions, replacements, and improvements are certainly among the most important functions of management because of the fundamental nature of such investments in the long-term growth and development of a business. This fact is generally recognized by operating procedures, by-laws, and the like, which require approval of such capital expenditures by top management and often by the board of directors. But, despite the recognition of the importance of these decisions, the criteria for evaluating the worth of proposed capital expenditures and for selecting the best of such proposals, are frequently not well-defined.

Often these decisions are made by rule of thumb, on a straight payout basis, on the selling ability of the person making the proposal, or on his good luck in getting an appropriation before the funds run out. The use of the return-on-investment concept can improve these decisions.

If the desirability of the proposed investment is measured by relating the earnings which it will produce to the amount of the investment, it becomes relatively easy to measure each such proposal against a minimum standard or against other proposals competing for the available funds. If there is a healthy generation of capital investment proposals, the amount of money requested in the aggregate for such expenditures will usually exceed the amount which the company is willing or able to commit. This situation suggests the desirability of a capital budget in which the *demand* for such funds for a future period of time, usually not less than one year, can be matched against the *supply* of funds available for the same period. If the list of projects constituting the demand are arranged in order of their ability to produce return on investment, the cut-off point is automatically determined when the list reaches the point where it equals the available supply of funds. It may be determined sooner if the return falls below the minimum return which is accepeable.

The capital budgeting process is greatly facilitated if proposed facilities projects are classified and examined according to the manner in which they are expected to produce return on investment. For instance, they might be classified in the four following categories:

1. Expansion projects —those in which the additional fixed and working capital investment must be justified by the profit expected to result from the expanded volume.
2. Product improvement projects —those resulting from changes in the product necessary to maintain or enhance its competitive position, for instance, annual model changes.
3. Cost reduction projects —those justified by cost savings.
4. "Necessity" projects —those not lending to direct economic evaluation but none-the-less required for reasons of safety, employee relations, local ordinance, state laws, etc.

Considerations in Setting the Return-On-Investment Standard

Up to this point, I have avoided any discussion of how the standard or minimum acceptable return on investment might be set, either as a goal of product-line performance or as a standard for use in decisions on proposed capital investments. Good judgment might dictate avoiding such a discussion entirely, since it can be a controversial matter. It could be debated, for instance, whether

or not the same standard should apply to two operating units, one of which employs a high proportion of working capital and the other a high proportion of fixed capital. It could also be debated whether a cost reduction project should be required to return as high a rate of return as an expansion project. These are matters which the reader might want to recognize in his own special situation. In point of fact, I think that just the setting of such a standard is of more importance than the precise accuracy of the standard itself. Nevertheless, I would like to offer criteria for the setting of the standard, which may serve to at least localize the problem, such as the following:

1. The standard should usually represent an improvement over present rate of performance.
2. Performance of best competitors might be an indicator.
3. In pouring capital into the business, the added capital should produce earnings which will at least equal, if not improve, the earning power of the stockholder's equity. An analysis of the company's own cost of capital from this standpoint can be quite revealing.
4. Finally, the determinant of the standard, at least with regard to additional capital invesment, may result from the amount of capital to be made available, depending upon the financial policies of the corporation at the time.

In conclusion, I believe that return on investment, which is clearly the end to which private business operates, can, as a concept, be employed in business planning and business decisions with a force not yet well-recognized. And, more particularly, I believe that the formulation and evaluation of profit improvement plans can be focussed and coordinated by an approach which recognizes their impact upon each of the three factors of volume, costs and assets.

Automation Is "In the Cards"—Prepare For It

by A. E. PUUTIO

Works Auditor, Richmond (Indiana) Plant, International Harvester Company

That degree and direction of technological advance in manufacturing and related processes, which is now commonly called automation, is brought to the fore in this article in terms of requirements which progress toward it will impose on accounting, engineering and manufacturing staff. A condensed but action-stimulating portrayal is offered.

TECHNOLOGICAL IMPROVEMENTS are affecting more and more manufacturing operations in this country. This is especially true in the motor car industry, although many other industries have made equally important strides along these lines. These improvements are being introduced to more and more manufacturing plants and the pace will be stepped up as their advantages and economies are fully recognized and proven. These technological advances are usually referred to as "automation," meaning automatic production. The increase in the tempo of adopting these improvements is daily becoming more apparent.

All industry will, no doubt, be affected in many ways by changes in this direction. Management will be called upon to face many difficult and perplexing problems. Past experience and practice may offer only slight assistance in discovering a solution. Methods and procedures will have to be changed to meet these new demands and revised again and again as the demands, themselves, are changed. Even now, it is not too early to begin planning for automation, although many of us think about it as a dream, to be realized in the far distant future. However, it is better to be prepared too soon than to be caught "off-guard" due to lack of foresight. The effect of changes which will result from the successive steps toward automation, can be minimized considerably through proper planning ahead. Proper research and well-organized plans will prevent confusion and chaos and will eliminate the possibility of losses in revenue and production when these improved methods are adopted.

Publicity related to automation, and perhaps the implications of the foregoing introduction, will doubtless have raised points for consideration in the minds of many readers. Such points are numerous and call for at least tentative listing. With this in mind, the writer has compiled a few of the more important items which must be considered. The list is, by no means, inclusive and in some cases, may not even touch upon one factor or another which may

prove to be the most important one for a particular industry. As given in the remainder of this article, these points are separated under the broad captions of accounting, engineering and manufacturing. This order is not that of importance of the considerations, even to accountants, but it seems sensible to deal first with the impact of automation on primarily accounting matters and then to deal with the highly-relevant broader picture.

Accounting Considerations: Overhead Distribution, Depreciation

Studies of present accounting procedures will, in most cases, reveal that they do not lend themselves fully to automation. Changes and modifications must be developed and put into effect before they can be aligned to reflect new developments in manufacturing methods. In the first place, distribution of overhead under present cost systems, especially those based on a direct or prime labor cost basis, may no longer furnish accurate costing under automation. The equipment involved will be very costly, with consequent increased costs for depreciation, maintenance, insurance and taxes and very little, if any, direct labor. It is obvious that direct labor cost cannot be used as a basis for distribution of overhead under these circumstances. A similar situation exists with respect to the other common bases which are used for applying overhead to products.

This condition seems especially serious when we recognize the fact that a majority of the manufacturing plants use the direct labor cost basis for distribution of overhead. Perhaps the newly-developed electronic accounting machines will aid in solving this problem. At least present indications appear bright in this regard. There is no simple solution to this problem or one that will cover all companies or industries. Possibly cost centers or work stations comprising individual units of equipment may be the answer, but the clerical detail involved might be too great, in most cases, to make this practical. The application of specific or standard overhead rates to individual units should suffice in other instances, but these rates must be based on sound analytical studies and be subject to review periodically. The ideal solution may require a completely new method for allocating overhead to the various producing units or products.

Proper allocation may require setting up standard units or points for each element of overhead, covering every productive operation in the plant. Such a cost system would require a considerable amount of research to establish the original common denominator or value for each factor or element of overhead but would then remain constant except when the method or design was changed.

The total points could then be related to total cost for each element of overhead to arrive at the value of the points for allocation of overhead to product costs. This method applies overhead charges on a nearly direct charge basis, similar to usual practice for prime material and labor. Minor variations are absorbed in cost of production or cost of sales.

A second point of difficulty under automation will be depreciation. Present plants, machinery and equipment will become obsolete at a much faster rate than has been the experience in the past. Present depreciation rates will no longer suffice and should be accelerated in those cases in which equipment will be replaced before it would be fully depreciated under present schedules. It is realized that depreciation rates for tax purposes are largely controlled by Federal Revenue Acts, Treasury Department rulings and especially Bulletin "F" of the Internal Revenue Code, but there still is room for some action. Market trends should be watched, including competitive changes and technological advances, so that claims for unusual obsolescence may be made in the proper year. This is only one of the many actions which can be taken but, first and foremost, each company must be ready to take advantage of any and all possible changes or reforms by Congress affecting the depreciation provision of the tax laws. It is impossible to measure the benefits which can be gained by proper planning along these lines. A plan of action covering contemplated and proposed changes is most important.

Accounting Considerations: Altered Sequences, Revised Reporting

There will, no doubt, be instances in which entire operations or departments will be eliminated by automation, because of changes in materials, product demand, or improved equipment and methods of manufacture. Some plants have already experienced this in past technological advances. An example is afforded by operations which have eliminated wood shops because of changes in demand or introduction of new materials. We must not mislead management under such circumstances, which we obviously would be doing if we understated actual costs. This would be the case if depreciation rates used did not fully depreciate the equipment involved over its actual useful life. Accountants can help prevent this situation only by constant research and study of the company situation respecting new materials, changes in market demands and impending improvements in methods of manufacture. It is their duty to assist management in making sound evaluations of altered conditions and they can do this best by furnishing complete and accurate information.

Certainly automation or any changed manufacturing process is a call upon

the accountant's judgment. Product unit costs must be evaluated, under both the present and proposed methods of manufacture, along with the profit or loss and the overhead absorbed by each. Proper evaluation and analysis of this information by accountants will enable them to point out the extent to which profits can be increased and costs reduced by new products or manufacturing techniques. Accountants would be neglecting their responsibilities if they did not assist in guiding management in this very important field of cost analysis. Proper organization in connection with a modernization and expansion program, with all factors receiving careful analysis, will prevent duplication, lack of co-ordination between old and new facilities and overlooked facilities for savings in time, labor and equipment.

The reporting program may not stand up under automation. Factual reporting to all levels of management must also be reviewed in light of possible changed conditions. Current reports, including budgets, operating summaries, etc., will probably no longer reflect the inefficiencies and areas of costs which must be controlled. It may be necessary to make an overall revision of the make-up and contents of reports and records. These changes, in most cases, can be made gradually as the need for specific detailed information becomes apparent. The out-moded reports should be discontinued as substitutions for them are made.

The Primary Engineering Consideration: Design

It will surely be found that design of many of the present company's products is not ideally suited for production under automation. Product engineers and designers must key their efforts to facilitate production under this new concept of manufacture. This involves recognizing an evolving situation in several particulars.

For one thing, basic designs or models must be developed to which special features, attachments or changes can be adapted to fulfill customer demands. Automation is exceedingly set in its ways so, without basic models, it would be impossible to secure the full benefits of increased production at reduced costs from these advanced manufacturing practices. Along with development of basic designs, there must be interchangeability of parts on the different models. This would increase volume of some items, which is vital under automatic production methods. Short-runs and variety must be the exception rather than the rule.

Further, product development must be keyed to the method and tools of fabrication. It will not be practicable to design the product and then decide how to build it. Simplicity of design will add much to the ease of manufac-

ture and is a "must" in all future designing. Such action, however, must be consistent with sound engineering principles and quality end-products. All this also places additional significance in forecasts. Demand for present and proposed products must be analyzed and coordinated with market research studies which forecast the long-range outlook for product sales. The benefits of increased production at lower costs can open up entire new fields of demand and market potentials. Competition will, of course, be much greater, especially from new designs, materials or because of excess capacities, increasing the danger of obsolescence of equipment as well as of the product itself. All of these factors must be considered in the long-range planning of present products or developing new or improved items.

Manufacturing Considerations: Facilities, Maintenance

The manufacturing departments will face many difficult problems as a result of these technological advances. The solution of these may be much harder than those faced by the accounting and engineering divisions. These problems will involve all of the mechanical changes in equipment and tools as well as changes in production, standards, planning, inspection and personnel departments. Proper investigation and planning will insure an orderly transition from present methods to the new and progressive operations. There are many items that must be included in such a study.

Some of these matters have a time limit. For instance, all procurements of machine tools, equipment or tooling need to be carefully analyzed for possible use under automatic or semi-automatic manufacturing methods. Expenditures for new facilities must be scrutinized to be certain that they can be utilized under future production practices. From all indications, obsolescence will be extremely heavy on most of the present facilities, so it would be folly to aggravate this condition by adding equipment which may have only limited use under future operations. Allied equipment, such as material-handling equipment, storage facilities, operational sequence, etc., must also be resolved to meet these same requirements. Moreover, new facilities, whether additions or improvements, must be so designed that they will have flexibility and capacity to produce all components which are basically similar. It may be possible to accomplish this by means of inserts or through mechanical ingenuity and thereby reduce the investment required. Proof of this should assist management in selling conservative boards of directors and stockholders on the benefits of expensive new equipment.

Maintenance in the automation era will become increasingly important. Most

of this will, of necessity, have to be preventive maintenance, in order to eliminate or reduce to a minimum unexpected, costly, and time-wasting shut-downs. Automatic controls and signals must be developed to warn of parts or tools which need replacement. Plans and procedures should allow for these changes to be made during lunch periods or between shifts.

Manufacturing Considerations: Personnel, Training

The reaction of employees and the public to automation is going to be a difficult psychological problem which must be solved. The threat of labor displacement will be vigorously resisted by both the workers and unions, in the belief that automation will mean job dislocation and unemployment. This view also is, unfortunately, shared by a large majority of the public. The objections of workers, unions and their leaders can be dispelled by a presentation of the benefits to be gained by them from automation. Displaced employees will, in most cases, be absorbed into stepped-up production schedules and usually, with proper training, in a new and more highly-skilled job. The physical burden on most individual workers will also be greatly eased, making for reduced worker fatigue and greater safety. Increased demand because of lower prices will insure greater job security with increased earnings, since most jobs will be of a higher skill type demanding a higher rate.

Encouraging employees to participate in projects looking toward automation will help in minimizing their objections. The public can be won over by reductions in selling prices, which are made possible by lower production costs. Quality cannot be allowed to suffer but can, in most cases, be increased by elimination of processing errors. It may be advisable to develop a public relations program to sell automation to the public.

Personnel training will require a new emphasis. The entire training, personnel and human relations program and policies must be reviewed and revised wherever necessary. Present systems and regulations may not only breakdown from the new heavy demands but may also prove inadequate and obsolete. These short-comings can encompass all levels, from top management down to the lowest workers. For example, management decisions and actions will become extremely important in an automatic plant. Errors in judgment or wrong decisions will prove much more costly than under present operations. Competent technical backgrounds will be required at all levels of operations. In most cases, comprehensive training programs will assist present management employees in developing sufficient skill and judgment to handle their new assignments. Those who cannot must be weeded out and replaced. In any

event, extensive management training programs, including brush-up courses at universities, job-rotation plans, conferences-in-training, will become a must by management.

As for workers and machine operators, they will give way to teams of skilled technicians controlling and maintaining individual units. Proper training and instruction will provide a majority of the present workers with the necessary technological knowledge to fulfill the demands of their jobs under these new conditions. Others and often long-service employees may face layoffs or even terminations due to lack of these skills or the ability to attain them. Union contracts and agreements will require changes to make these moves possible.

In view of the possible termination of both managerial and nonmanagerial employees, due to lack of ability, or knowledge or both, it may be necessary to make some changes in present retirement or termination policies. These should be developed prior to the time the need arises. Some incentives must also be discovered which will keep employees producing at normal effort until the advent of automation. This may prove the greatest stumbling block during the transition period.

New yardsticks for measuring factory efficiency must also be developed and stressed. The much-used ratio of productive to nonproductive employees will no longer be applicable, since productive employees will be entirely eliminated in some cases. Nonproductive may be increased. Needed ratios may not be too difficult to design, but getting management to accept them is another problem requiring solution.

Not Tomorrow—But the Day After

Although the day of the completely automatic factory is still far off, many automatic elements are here today and more are being introduced each month. The benefits from these improvements are too great to be overlooked or passed over lightly. Well-laid plans and proper organization may mean survival in the new strongly-competitive economy. An alert management can make the transition of automation an orderly process instead of entering a period of confusion and indecision. Progress must be our by-word. It is with this goal in mind that this paper is offered. Proper planning will usher in a brighter future with increased productivity and unchallenged progress.

Enter — Operations Research

by JOHN F. MAGEE

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The reader of this article will draw near to what operations research is and does (and would do) through general characterization, contrast with general accounting and cost accounting as developed to date, and outline of the utility of operations research in systems design and in studies of segments of company operations. Three briefly-depicted research-team studies, one of which reflects the mathematical tools which the technique requires are described.

OPERATIONS RESEARCH IS THE ORGANIZED APPLICATION of the methods and techniques of science, particularly the physical sciences, to the study of operating problems in business, government, or the military. The objective of this work is to gain an explicit quantitative understanding of the essential elements of an operation and the factors affecting results, in order to give management a sounder basis for decisions. Operations research is an experimental field. Its goal is to provide quantitative theories describing operations, which will stand up under experimental check. A well-organized and staffed operations research team brings to a business organization the use of the scientific method, supported by a command of technical methods of experimentation and analysis applied to the company's operations viewed without departmental bias.

What Is Operations Research?

A number of papers and articles have appeared in technical and popular publications which give definitions of operations research—a task which is none too easy. Indeed, the problem of defining research in general terms is, itself, a very difficult one. One definition has been quoted, perhaps facetiously, describing research as "looking at bugs through a microphone." Therefore, we may be able to dodge the problem of formal definition of operations research by saying it is the same kind of research, where the bugs studied are those found in business operations.

Operations research is research in complex operations. This kind of research involves, however, a particular view of operations and, even more important, a particular kind of research. Operations, that is, the activities of men and equipment conducted for the purposes of the business—are considered as a unit, as a total economic process. Emphasis on a unified view of company operations is important to success of operations research. However, this does not

imply that the company as a whole must be studied in every problem. The important point is that a team working on a problem of restricted scope must be free to explore the boundaries of the problem, to examine the suitability of subsidiary goals, and to challenge restrictions imposed on the operation under study by other, related operations in the company.

The operations studied are subjected to analysis by the mental processes and the methods which we have come to associate with the research work of the physicist, the chemist, or the biologist. Operations research brings the capacities of the trained scientist, with his analytical and research mind assisted by mathematical and experimental techniques, to bear on industrial operating problems. It is an experimental field. The conclusions derived must be verifiable, both in theory and in practice. As an applied field, operations research is intensely practical. It is aimed at useful results. The goal of an operations research team is to provide quantitative knowledge which management can use to make better decisions. The research is aimed, not only at understanding, but at solving action problems.

The most frequently-encountered concept in operations research is the concept of the model. The operations research model, like an engineering or accounting model, is a simplified representation of an operation, containing only those aspects which are of primary importance to the problem under study. An operations research model may be mathematical, in the form of a set of equations relating significant variables in the operation to the outcome, or it may be a punched card model, where decks of punched cards are manipulated to represent functioning of the operation. Operations research models may be exact, where chance plays a small part, or they may be probabilistic, containing explicit recognition of uncertainty. The construction of the model, or abstract representation of the operation, is the scientist's first major goal. The remaining task is interpretation of this model or theory.

A second fundamental concept is that of decision and decision-making. The element common to all true operations research problems is the existence of alternative courses of action, with a choice to be made among them. From the point of view of operations research, the operation is a set of decisions or strategies, with an outcome related to each. The objective of operations research is to show clearly the relation between the outcome and the possible courses of action, to assist the executive in making his decision wisely. In every case, however, the ultimate choice of the course of action lies with the executive.

Another important concept is the role of experimentation. Operations research aims to be the application of experimental science to study of operations.

The theory describing the operations, as contained, for example, in the model, must be experimentally verifiable. This means two things: first, verification must be possible and, second, when experiments are made, theory and observation must check.

These methods and concepts—the research attitude, the search for explanations of phenomena, the construction of models, and the experimental attitude—characterize operations research as the application of scientific attitudes and methods to the study of operations, in order to help executives improve decisions.

Operations Research and Accounting—Comparison and Contrast

Operations research and accounting have many basic interests in common. Both are concerned with quantitative aspects of business operations. Both, moreover, are aimed at providing business management with an improved basis for judging performance and with quantitative information on which decisions can be made. Despite these similarities, there is a marked difference in method and objective between operations research and accounting.

The accounting function in business has been historically what the term, accounting, implies, namely, the regular recording and reporting of the flow of values in a business operation. The purpose of accounting has been the protection of assets, with ancillary legal purposes. To perform this function, accounting is based on a body of principles and doctrines which have developed over a period of many years. These are constantly going through a process of evolution, as the accounting needs of the business change. However, consistency of accounting practices between today and the past is a strong virtue. In the course of its development, it has been necessary for accounting to introduce conventions peculiarly adapted to its basic needs and, for the purpose of its historic role of protection of assets, to introduce accuracy which at times appears to the lay person to verge on the extreme.

The control function, in the sense now comprehended in accounting circles, is relatively new. Accounting systems in existence today generally are designed to provide adequate protection of assets and legal control, but the large number of accounting systems which provide no effective operating control information bear witness to the relative novelty of the control function in accounting.

Operations research, on the other hand, is a research function. Operations research groups are not in existence to provide a historical record or to perform a regular reporting function. Their objective is to learn more about why a business operates the way it does. For this, regularity and historical consistency

are not necessarily virtues. The work of such groups may in fact generate an expanded or recast reporting function in some areas, as it gives business executives a better understanding of how to define business needs for information for control and decision-making purposes. The contrast and interdependence of the research function of the operations research team and the recording and reporting function of the accounting group will be illustrated by the discussion of two areas of particular interest to both groups, design of information-handling systems, and operating studies based on cost information. In presenting the place of operations research in these two areas, there will be given in brief outline three applications, one related to systems and the other two to studies of operations, including (but not limited to) their control.

How Operations Research Serves in Systems Design

As business functions in organizations have grown in complexity, business managers have leaned more and more heavily on their accounting systems for information for control purposes. Businessmen in many companies are coming to recognize, however, that they have never thoroughly understood what kinds of information they want, in order to exercise adequate control, and how accurately, and to what degree. They have, therefore, been unable to specify carefully for their accounting systems the scope and type of reports needed for control purposes. As a result, there has perhaps been a tendency to adapt existing financial records—manufacturing statements, profit and loss statements, and the like—for use as control documents, rather than to develop specific control reports meeting management needs from the point of view of speed of preparation, degree of accuracy, format, and scope.

This problem is becoming of growing importance as business managers find themselves faced with:

1. Constantly decreasing direct control over their operations;
2. Rapidly increasing cost of processing a growing quantity of detailed control information.

Recognition of these problems by businessmen has generated increasing interest for a new view of control systems, and the reappraisal of the control function as the information-handling and reporting operation of the business.

The accounting and operations research groups can cooperate effectively to help the businessman meet his information-for-control requirements. The function of increasing importance in the accounting organization is that of supplying information which becomes the basis for managerial control. The function of the operations research group, through its studies of business operations, is to find the needs for control information.

Case of a Parts Manufacturer

To illustrate the application of operations research to systems design, there may be cited the case of a large-scale manufacturer of components of industrial tools and electrical equipment engaged in manufacturing operations of a job-shop character. The management of the company felt, simultaneously, a lack of adequate pricing data and a need for better scheduling methods to control operations. The developing awareness of these needs led to a joint attack by the operations research and accounting teams on the problem of organizing better control data. This study quickly led to the recognition by the study team and the management, of the need for a new concept of its accounting system.

The company set as its objective the development of an information-handling system designed primarily for control, with financial recording being a subsidiary function. The basic objectives in the system were to be flexibility and speed, with fine accuracy sacrificed in many areas to maximize attainment of these objectives. A central information system was designed to provide from a single source data for sales analysis, production scheduling, cost control, and production analysis, as well as financial records. Indicated results are the expanded usefulness of the accounting function within the company, the availability of more and better data for further operations research studies, and better control over operations by the company management.

Operating Studies—the Example of Inventory Control

The function of the operations research group goes beyond the problem of specifying control information to be collected and published on a regular basis. The basic purpose of an operations research team is learning the fundamental characteristics of business operations to see whether, and to what degree, operating methods can be modified within the existing characteristic framework and what types of modifications may be worth while. The sources of information for these studies may range from past statistical data on the company's operations to experiments run to study special operations or possibilities. One of the most fruitful sources of study information is accounting data and the source documents for the accounting function. Use of this data, however, requires the closest cooperation between the operations research and the accounting groups, so that the operations research group will understand the accounting purposes and methods and will appreciate the reasons underlying particular accounting techniques which may be in use.

For example, inventory control problems depend basically on two kinds

of costs: production costs and costs associated with inventory management. Production costs, in turn, break down into direct and indirect costs. Direct costs include overtime, setup, and similar costs. Indirect costs include hiring and training costs, costs due to lessened quality when schedules are changed, and overhead items which may be affected in subtle ways by changes in production schedules.

Cost associated with inventory management, also break into two categories: true inventory management costs (such as handling, storage, obsolescence) and investment costs (including an imputed charge for the capital tied up in inventory investment). The definition of inventory investment may vary widedly, depending on the particular form of the production planning or inventory control problem under study. In some cases, for example, the full accounting cost may be the appropriate base against which to charge for investment. In other cases, only direct or out-of-pocket costs are appropriate. In still others, even some of these costs may be excluded because of particular operating practices. An understanding of the method of collection of accounting data and the definitions underlying accounting categories, as well as an appreciation of the accounting methods used, are essential if the operations research team is to be able to locate and use the necessary cost data.

Case of a Manufacturer of Cleansers and Polishes

A manufacturer of cleansers and polishers sold largely to the small consumer market, faced continuing interdepartmental battles among production, finance, and sales organizations concerning the level of inventories to be maintained during the year. The highly-seasonal character of the business, with a large sales peak during the summer months, created three conflicting requirements: a demand by the production organization for uniform production, with large inventories taking up the slack between production and sales; a demand of the sales organization for adequate inventories at all times in the year to meet fluctuations in volume and a demand of the financial group for minimum inventory balances to reduce the necessary investment in inventories and the corresponding drain on working capital.

The operations research team was able to use linear programming techniques to balance the conflicting objectives of the production, sales, and financial organizations, and thus to provide a schedule which would serve the best interests of the company as a whole. In setting up this system, the operations research group found it necessary to rely heavily on the accounting organiza-

tion for cost data, although the definitions of costs used differed substantially from those used in the normal accounting system.

The linear programming solution to the production-scheduling problem can be illustrated by the mathematical expression shown below. The objective of the schedule is to minimize the costs affected by changes in the production schedule which were, in this case, principally the costs of overtime operation and the imputed interest cost of inventory investment. The cost function to be minimized could be shown to be:

$$C(x,y) = \sum_{i=1}^{k}\sum_{j=1}^{h} rQ_j(k-i+1)x_{ij} + \sum_{i=1}^{k}\sum_{j=1}^{h} rQ_j(k-i+1) + P_j\, y_{ij} - \sum_{i=1}^{k}\sum_{q=1}^{i}\sum_{j=1}^{h} S_{qj}$$

where

$C(x,y)$ is the total of inventory carrying costs and overtime costs affected by the schedule,
x_{ij} is the amount of product i to be produced in period j on regular time operation,
y_{ij} is the amount of product i to be produced in period j on overtime operation,
P_i is the added cost resulting from producing a unit of product i on overtime operation,
Q_i is the added investment required to carry an additional unit of product i in inventory for one month,
and r is the monthly interest rate imputed against inventory investment.

This mathematical function was to be minimized subject to the following restrictions:

Regular time capacity limits

$$m_{ij} - x_{ij} \geq 0 \qquad i = 1, 2, \ldots k;\ j = 1, 2, \ldots h$$

$$m_i - \sum_{j=1}^{h} x_{ij} \geq 0 \qquad i = 1, 2, \ldots k$$

Overtime capacity limits

$$n_{ij} - y_{ij} \geq 0 \qquad i = 1, 2, \ldots k;\ j = 1, 2, \ldots h$$

$$n_i - \sum_{j=1}^{h} y_{ij} \geq 0 \qquad i = 1, 2, \ldots k$$

Inventory restriction

$$\sum_{q=1}^{i} x_{qj} + \sum_{q=1}^{i} y_{qj} - \sum_{q=1}^{i} S_{qj} \geq 0 \qquad i = 1, 2, \ldots k;\ j = 1, 2, \ldots h$$

The constants m_{ij} and n_{ij} are the capacity restrictions on line j in period i on regular and overtime production; m_i and n_i are over-all plant capacity limits in period i. The final restriction states that the inventory must not become negative.

The overtime costs p_i could be obtained directly from the accounting records. The unit inventory investment charge, Q_i, could also be obtained from the

accounting records but differed from the normal inventory unit values, in that only the direct labor and material component costs were included. The rate of interest charged against capital tied up in inventory, r, appeared nowhere in the basic accounting records but was established by the management to reflect the need on the part of the company to conserve its working capital resources. The rate of interest was changed from time to time, as cash availability conditions changed.

Case of a Retail Chain

The accounting system of a large, far-flung retail store chain organization had been set up primarily for the protection of assets and the estimation of profits earned in individual store units. In an organization of this character, conservation of asset and evaluation of profitability become of extreme importance. The accounting data drawn together from this chain, at some expense, was also used by the chain management for control purposes. The management recognized the limitations of the financial documents produced by the accounting system for its control purposes but had not been able to define its control needs in a sufficiently satisfactory manner for the accounting organization to adapt its reports to these needs.

The studies of an operations research team showed how statistical methods could be applied to the accounting data or, at times, to samples of it, to produce control information. The team showed how the same accounting data could be interpreted to show hidden conflicts between the company's objective of return on invested capital and the store managers' objective of maximum bonus.

What Does Operations Research Bring the Company?

An operations research team brings, first of all, the scientific or research point of view aimed at the operating problems of the company. There is a recognizable and important difference in the administrative control and the research point of view. These differences are recognizbale in the patterns of thought habitually used by the line executive, the accounting executive, and the physical research scientist. The function of the operations research team is to bring the point of view of the physical scientist to complement the attitudes of the line executive and the controller in studying and improving business operations.

Modern industrial companies support many activities which fall under the general classification of research, including, for example, market research,

economic research, and physical research and development. However, the physical sciences, particularly physics and chemistry, have gone furthest among these varied activities in organizing and specifying a method and an approach to research investigation and problem-solving.

The social sciences and allied business activities have gone a much shorter distance toward the organization of the research method. They have contributed much less toward the development of powerful experimental mathematical and analytical tools. There are many reasons why this is so. Perhaps it is now time to stimulate the development of research in the social fields and associated business research areas, by drawing upon the powerful techniques the physical scientists have developed for handling problems of growing vagueness, uncertainty, and complexity.

The use of the scientific method of thought, the cycling of hypothesis, model-building, and experiment, is fundamental to operations research. Through it, the scientific methhod becomes workable by the command, on the part of the research team, of technical methods of experimentation and analysis. This combination is what the operations research scientist brings to business. Thus, the factors which differentiate operations research, in the main, from existing management service groups are, as indicated at the start, the extended use of the scientific method, supported by a command of the technical methods of experimentation and analysis applied to the company's operations viewed as a whole, rather than from some specific point of view such as marketing, production, or engineering.

This combination of method, technique, and viewpoint which characterizes operations research, has shown its ability time and again to make a significant contribution to business operating efficiency. In particular, the growing body of inventory control and scheduling theory promises to reduce one of the knottiest problems existing in business, by balancing conflicting interests to workable scheduling methods which management can control to achieve its goals. Research in the area of consumer and sales behaviour is a growing and promising field. Finally, the development of methods for analyzing information-handling and production systems as unified schemes, shows indication of being one of the most significant areas in which operations research teams can contribute to effective business management in the future.

Processing the Termination Claim

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Readjustment of defense programs and outlays are harbingers of partial—and sometimes full—terminations of government contracts. The text of this article, written by an accounting official of a company engaged in defense work, calls timely attention to the important features of settlement claim preparation, including presentation of termination inventories, admissability of costs peculiar to the termination situation, determination of profit allowed, and other pertinent aspects of accounting for curtailed contracts.

A COMPANY MAY BE INVOLVED in a termination with the government when the latter terminates all or part of a prime contract at its convenience. In ordinary contracts for work or services, the measure of damages for breach of contract is the full anticipated profit. This is not so with government contracts. This article is based on studies made of the most recent government policy releases of the Department of Defense, relating to termination of contracts. In the light of these, it sets forth the requirements to be observed by a company in preparing a claim for contracts terminated for the convenience of the government.

All government contracts contain termination clauses. All termination clauses apply to supplies manufactured and services performed within the continental United States. The government usually reserves to itself the right to terminate any contract at its convenience or option, and to pay a company only for the costs incurred for the uncompleted portion of the contract, with a profit factor for the work done. A large percentage of claims will involve accounting and cost accounting interpretation which will be very important in the preparation of termination claims and final settlement.

Termination for convenience of the government should not be confused with a termination that arises when there is a default in the contract. The first assumes that satisfactory performance has been given, but that a change in the federal government's procurement program has forced it to cancel a portion or all of the contract. There would be a termination by default if the company did not live up to the terms of the agreement. This paper is not concerned with such terminations.

The contracting officer is authorized not only to terminate a contract for the convenience of the government but to enter into a settlement agreement, called a supplemental agreement, upon completion of the termination negotiation. The

contracting officer also examines the settlement proposals, negotiates full or partial settlement, and concludes the settlement agreement, including financial settlement. In the event of two or more claims representing several contracts, he may approve joint or consolidated settlement. The effective date of termination is very important because experience indicates that many disallowances are made on costs incurred subsequent to the termination date.

It is best that notification of cancellation and any agreements reached in negotiation or otherwise, be in writing. Moreover, it is obvious that the contracting officer will be requested by the company to make a great many decisions before a claim is finally closed. Any such decisions involving principles which appear to be deviations from the normal or outside the intent in regulations as interpreted by the company should also be in writing.

What is Involved in Settlement: Bird's Eye View

The first step in the settlement of a terminated contract must be the preparation and presentation by the company of an accurately compiled accounting claim, including a detailed inventory of materials, parts, sub-assemblies, machine tools, machines where indicated, jigs, dies, tools, fixtures, and patterns for which the company specifies reimbursement. This inventory must be accurately counted, priced, costed, summed up, and must be included on the mandatory forms with complete information supplied as indicated on the forms. This information includes some items which are not ordinarily a part of commercial inventory. An instance is the required detailed description of the materials, weights and property disposal recommendations.

The necessity for compilation of this inventory suggests the advance training of personnel to meet the problems which will be presented by a termination. This requires adequate procedures, amply illustrated and well thought out. The procedures should give the duties of each division and related departments, so that a claim can be presented in a routine manner. To this end, a special termination inventory ticket should be designed on which all the required information can be gathered and will suffice to act as a medium for relieving the proper inventory accounts, for inspection results, for final destination of such materials and for pricing the inventory in detail in a manner conformable to government requirements.

Having compiled the inventory, a company must then summarize the claim on the mandatory forms. The claim will include administrative overhead, profits, and post termination expenses. When the complete claim has been presented to the contracting officer, the process of settling it begins. Before it can be paid

in full and the property finally removed from company custody, the contracting officer or his representatives must have approved the disposal of each item of inventory and examined the propriety of each item of expense and profit.

The amount paid to a company in settlement of a terminated contract is, unless the courts are resorted to, a matter of negotiation or determination under a formula. In negotiation, the contractor may obtain costs plus a reasonable profit. Under formula, he generally obtains costs plus two per cent on costs of material acquired for the uncompleted portion of the contract, eight per cent of all of the costs except subcontractor's costs, but not over six per cent of the total costs. The government desires a rapid settlement of contracts and government agencies are geared to a negotiated closing. As a result, the formula is reluctantly resorted to.

However, as already indicated in summary form, there are many steps which precede the negotiation. Before a prime contractor can sit in a meeting with the representatives of the government to settle, he must have the settlement proposal, detailed inventory, government or company accounting review of subcontractor's claims, an agreement for the full clearance of surplus property, and clearance of all subcontractor's claims.

Departmental Impact of Termination

Each division of a company occupied with its particular current problems, tends to look upon a termination as a "dead" matter for the attention of specialists who may be interested in it. A special group which would carry the termination work load of each division would be a costly set-up. Therefore, to be effective, all functions connected with terminations must be intergrated into the normal work routine of existing departments' personnel by means of procedure study and without the intrusion of termination specialists. All decisions relating to the termination are made by a policy committee representing each division's management. The Comptroller, who is responsible for the final presentment of the claim, is the permanent chairman.

The sales department is the natural contact with the contracting officer, because it initiated the contract. The company generally wants to know whether or not, through this contact, a partial termination can be adjusted as to the rate of output and the date of the last shipment, so as to cause the least disturbance as possible. The company is also interested in knowing whether spare parts will be required on a long-term basis or whether there will be a stand-by program for the product. It would like to know whether ninety per cent complete items can be finished or is the product considered obsolete.

The company must stop its work on the contract. This will be done through production control and other departments on advice from the sales department. It is to a company's best interest that the sales department permit no delay in informing the departments involved. Determination of what subcontractors are involved and the extent to which purchase orders should be cancelled or cut back is a function of the production control department because this involves inventories and continuing demand figures. The production control department must consider the demand for spares and other contract requirement before calculating the quantity to which termination is applicable. Upon the notification of the quantity involved, the procurement department cancels or modifies the purchase orders. Where it can be determined that a diversion of materials from the cancelled contract, at cost, would involve a loss to the company, consideration should be given to including such potential diversion in the claim, giving the contracting officer ample evidence for nondiversion in spite of existing demand.

The job of physically establishing the prime claim inventories on termination tickets and schedules belongs to the manufacturing and engineering departments. This includes an inventory of work-in-process, finished parts, assemblies, finished units, tools and test equipment.

After the costs are applied to the termination transfer tickets by the cost accounting department, the books are relieved at existing absorbed overhead rates, and the tickets are repriced at applicable termination overhead rates and a unit cost computed. The tickets are then rearranged for preparation of mandatory schedules. After all of the cancelled inventories are charged to the termination account and set forth in the proper schedules, the schedules prepared for the government are turned over to the general accounting department for review.

Inventory and Total Cost Bases as Principal Settlement Choices

The settlement proposal should list cancelled inventory costs, include settlement expenses, plus any settlements with subcontractors. It is often difficult to determine the total settlement expenses or subcontractor's claims at original filing of the proposal. Therefore, interim claims may be filed until all data is compiled and the final claims prepared. The company is allowed two years (or a period of time specified in the individual contract) from effective date of termination, to file the proposal, but it should be filed as quickly as possible.

One of the most important problems before the machinery can be set in motion for gathering data on costs is determination of the accounting basis for

preparing the settlement proposal. There are four cost accounting methods which may be employed by a company as a basis for preparing a termination claim. They are the inventory basis, total cost basis, percentage of completion basis, and any other reasonable basis. When a basis is chosen, it must be recognized that the admissible costs are those sanctioned by recognized commercial accounting practices.

The company is not bound to prepare a settlement in exactly the same manner as is followed in keeping the company accounting records. If the accounting system was established for the purpose of the control of costs and other special purposes, it may be unsuitable when applied to the preparation of the settlement proposals. However, this does not mean that the government will allow the company to select the basis which will give the greatest recovery. The company carries the burden of proving that ordinary methods do not give fair compensation. The claim must be prepared under a method which will produce an accurate statement of total costs.

The inventory basis is most frequently used. Under it, a termination inventory is taken of raw material and purchased parts, both priced at purchase cost. Work-in-process and component parts completed are priced at manufacturing cost. This cost includes materials, labor and applicable overheads. All other elements of cost, such as engineering, methods, tooling, etc. are listed. The inventory is listed on a statement of charges incurred prior to termination. General administrative overhead, settlement expenses and subcontractor's claim are also listed. Finished products, as of date of termination, are either shipped out with approval of contracting officer and billed at sales price, or included in the settlement proposal as acceptable finished products. If the latter, they are priced at sales price.

In the absence of unit cost information or when the contract is terminated in the early stages of performance, an alternate method, known as total costs on the contract to the date of termination, is applied and a profit allowance added. Deductions are then made for all amounts paid or to be paid for completed articles. The total cost basis is used when it is impractical to use the inventory basis. All costs incurred to the date of termination are listed. All allowance for profit is made on total costs incurred, or an adjustment for loss is made, and all payments made for completed units shipped and billed are then deducted. To this amount are added subcontractor's claims and other necessary expenses. The most practical way to handle this choice of methods for fixed price contracts, is to prepare the claim using both methods and then decide which form of settlement proposal is more suitable in the particular circumstance.

The agencies of the government prefer the use of the inventory basis, because it considers as costs only those directly attributable to the terminated portion of the contract. The inventory basis presents a cost problem for pricing work-in-process and incompleted tooling jobs, unless labor costs are maintained by operation and part number. The inventory method is usually chosen if (1) the costs for the uncompleted portion of the contract are mostly raw materials and purchased parts unprocessed or (2) there is not a substantial amount of work-in-process or (3) there is sufficient cost data available by operation to price the work-in-process inventory or (4) if the termination takes place during the later stages of performance.

The total cost basis necessitates a review of all costs incurred on the contract to date of termination. It is particularly advantageous if manufacturing operations have just started. Thus, the preproduction engineering or starting load costs, get into the costs presented in total through the simple process of listing all cost incurred. It is helpful to claim full re-imbursement for these in a case in which the contract is terminated in the early stages of performance. For the same reason, it may be helpful with older contracts where there is no full recovery of unusual costs at the start. As a rule, the total cost basis is used on a minority of claims. In the absence of dependable cost information, however, it is desirable to use the total cost method.

With respect to cost-type contracts, the armed services procurement regulations, regulations of military departments, and the prescribed standard termination clauses, either require or permit the vouchering out of all costs. The company may elect to negotiate both fee and costs in the termination settlement or restrict negotiations to the fee alone. In the event that an election is made to include costs in the negotiated settlement, the company should promptly discontinue the presentation of cost vouchers except resubmission and reclaim vouchers. The company may elect to continue presenting cost on cost reimbursement vouchers for a prearranged or an indefinite period. When the company elects to discontinue the use of cost vouchers, the company identifies the final voucher submitted. It will not be permitted to resume use of cost vouchers thereafter. After this discontinuance of cost vouchers, the company presents a claim for the reimbursement of costs on a settlement proposal. However, accounting information required on termination in connection with terminated cost-type contracts is generally the same as that under the fixed type contracts.

Admissable and Inadmissable Costs—In General

There are no government requirements that the company shall follow a particular account classification in its cost system, so long as it furnishes perti-

nent accounting information. It is the purpose of this section of the present article to consider the broad principles governing the determination of costs under government contracts and to include in the discussion sundry other costs which may be admissable if a contract is terminated and which would not necessarily be, if the contract had been completed. It is well to say at the start that costs do not become inadmissable because they are not mentioned in the contract or elsewhere. Such items stand or fall on their own merits. The general basis upon which costs may be declared unallowable are as follows: costs not incident to, nor necessary for, the performance of the contract; costs construed to have been incurred contrary to public policy, costs to the extent considered unreasonable in amount, costs for which recovery was contemplated as part of the contract fee or profit, costs specifically cited as unrecoverable from the government by reason of statute or regulation. Specifically inadmissable costs include bad debts and reserves for such debts, and commissions and bonuses in connection with obtaining or negotiating for a government contract, dividend payments, losses from sales or exchanges of capital assets, losses on other contracts, taxes and expenses in connection with financing, refinancing, or refunding operations, materials or services purchased or worked on in excess of the reasonable requirements of the contract.

If a cost is not disallowable under circumstances just discussed, it may be admissable if it is not contrary to contract terms or specific applicable regulations. The government sets the rules on some specific items but does not cover in regulations each item of possible cost which may arise. As a result, it depends and accepts as governing, the general interpretation of manufacturing cost sanctioned by the practices of industry. Attention is also given to the treatment of expenditures by the public accounting profession and recognized accounting associations. Admissable costs include direct costs which are reasonably necessary for contract performance and indirect costs which are reasonably necessary for performance of the contract and properly allocable to the terminated portion. In application, the following points govern: reasonableness, generally accepted accounting principles and practices, limitations as to types or amount of cost items set forth in the contract or in written records of negotiation, and allocability.

Direct Costs

Allowable material costs include the cost of all items purchased directly for (or used in the process of fabricating or consumed directly on) the product. In presenting a settlement proposal on an inventory basis, the raw material and

purchased parts should be priced at cost. A recognized and consistent method of pricing should be used. Examples would be specific identification, weighted average cost, weighted moving average, first in first out, *et al.* In calculating cost of materials, all discounts, including cash discounts, trade discounts, rebates, and any other allowances and credits taken by the company are to be deducted. These credits may be applied directly to the charges for the materials involved or may be apportioned through credits to indirect costs. Where discounts are available but not taken because of financial inability or other reasonable cause, the company will not be penalized. The military service auditors prefer handling of these discounts as direct reduction of material costs, so that the charges to contracts will be net. However, only cost-reimbursement type contracts are usually handled in this manner. Under fixed price contracts, fair apportionment through overhead adjustment is all that is necessary.

The company should scrutinize, for appropriateness to the contract in question, the type of materials and the quantity listed on the termination inventory schedules, because the government audit agencies will scan bills of material and design specifications for the reasonableness of the terminated inventory. Due allowances for overages because of manufacturing hazard will have to be considered. Material in company stockrooms prior to date of contract cannot be included unless proven to be necessary for the terminated contract. Neither can common items which could be used on other contracts. Material which can be diverted to other contracts must be removed from the claim with, proper credit to the contract.

Direct labor is considered to be the salaries and wages charged directly to the contract. Normally, such compensation will be charged at actual straight-time rates and will bear its portion of bonuses and shift premium through overhead application, unless other methods are used in the cost system. These methods are acceptable so long as they are equitable and consistently followed. To support direct labor cost for audit purposes, labor cost cards, clock cards, time check reports and payroll records should be available. Accumulating labor costs on a contract under a total cost basis of settlement proposal is generally not much of a problem, whether the company has a job order or process cost system, or a standard cost variation of either. A settlement proposal submitted on an inventory basis, where a job order cost system is encountered, presents difficulties in pricing of work-in-process unless cost by part and operation is ascertainable. Estimated costs may be used in the absence of actuals or reasonable standards.

Other direct costs chargeable on termination may include those types of

costs directly chargeable to the contract which do not enter directly into the fabrication or forming of the product but are demonstrated to be specifically related to the terminated portion of the contract. These may include the engineering and development costs, the cost of special tooling, methods and processing work, and the purchase of material and services directly attributable to the contract. Charges such as these may be considered in total and, if there is a number of deliverable units, this quantity can be used to divide the charges between the cost of the product shipped and the terminated portion of the contract.

Starting Load Costs; Reconversion Costs

Starting load costs may be allowed in termination. Initial or starting load costs are costs of a nonrecurring nature which arise in the early stages of production and which have not been absorbed on the completed portion of the contract due to the fact that fewer articles were produced because of the termination than were called for in the contract. Initial costs may include labor costs and related overhead, which is particularly high in the early stages of production because of excessive defective work resulting from inexperienced labor, idle time and subnormal production occasioned by changing methods of processing, cost of training employees, and the unfamiliarity or lack of experience with the product, materials, manufacturing processes or techniques.

It is not necessary for allowability that initial costs be segregated and amortized on the books of a company. The segregation may be made from cost reports and schedules which reflect the high unit costs incurred during the early stages of the contract. When the settlement proposal is on the inventory basis, a reasonable amount representing the excess production costs incurred during the initial period may be so segregated and allocated between the completed and terminated portions, normally on the basis of units delivered and to be delivered. However, if the product is of a diverse nature, some other equitable basis may be used, such as machine or labor hours. Of course, when initial costs are included in the settlement proposal as a direct charge, they cannot be included in overhead also. The initial costs of one contract may not be apportioned to other contracts.

The expense of the conversion of the company's facilities to uses other than the performance of the contract is generally disallowed. Under certain circumstances, this type of cost may be allowable. An example of this is property damage resulting from the removal of special facilities for delivery to or dis-

posal at the direction of the Government. Of course, realignment or relocation of production lines for performance of other work will not be considered allowable.

Indirect Costs

Indirect costs on government contracts are generally spread over, and collected in, several types of overhead, i.e., manufacturing labor overhead, material overhead, and general and administrative overhead. The generally acceptable means of proration are applicable to settlement proposals submitted. The additional factor to consider is that the period in the determination of the applicable rate should be representative of the cost period involved in the settlement proposal. Also—and this is as true of going contracts as it is of terminated ones—whenever items ordinarily chargeable as indirect costs are considered as direct costs, the cost of similar items applicable to other work of the contractor must be eliminated from indirect costs apportioned to the contract.

Advertising costs directly related to the advertising of the contractors' products and reasonably allocated to the terminated portion of the contract may be included. The contractor must have a consistent method of advertising and a reasonable one. Another category is compensation of officials, which includes all amounts paid, accrued, or set aside by way of salaries, fees, license fees, royalties, bonuses, and pensions, retired and deferred compensation benefits. The amount must be reasonable as measured by overall benefits from services rendered and must be allocable to the terminated portion of the contract. Expenditures for the improvement of working conditions, employer-employee relations and standards of performance may be allowed to the extent considered reasonable and necessary. Experimental, research and development expense specifically applicable to the types of supplies or services covered by the contract may be allocated to it. General experimental and research expenses may be allowed to the extent consistent with an established program of the company and to the extent related to defense purposes.

There should be mentioned here a broad limitation on certain costs discussed in this section of the present article. In no event may the aggregate of the amounts allowed in respect of initial costs and preparatory expenses, loss of useful value for special machinery and equipment, experimental, research and development expense, special leases, engineering, development and special tooling, exceed the amount which would have been available from the contract

price to cover these items if the contract had been completed, after considering all other costs which would have been required to complete it.

Settlement Costs

Settlement expenses include reasonable accounting, legal, clerical and other expenses necessary in connection with termination and settlement of the contract and subcontracts and in connection with the settlement proposals and cost evidence. Settlement expenses may also include reasonable storage, transportation and other costs incurred for the protection of property acquired or produced for the contract or the disposition of such property. Special leases, such as lease rentals proved to be necessary for the performance of the terminated contract, less the residual value of such leases, may be allowed. Allowable also is the cost of reasonable alteration of premises and also reasonable restoration costs. Salaries and wages of indirect workers and indirect work of direct workers may be included. Taxes, except Federal income and excess profit taxes are allowable. Vacation, holiday or severance pay, sick leave and military leave to the extent required by law, employer-employee agreement, or by the contractors' established policy are also allowed.

Settlement expenses are subject to audit by the agencies and, if a contractor does not have supporting data, he will encounter difficulty in obtaining reimbursement on all these costs. Generally, no overhead of a manufacturing or general administrative nature will be allowed as an item of cost on settlement expenses. Therefore, it is important that all expense incurred, applicable to the claim, be rendered as a direct charge to it. The settlement expenses should be summarized and listed on appropriate schedules for inclusion in the settlement proposal.

Immediately upon receipt of termination notice, the accounting procedures should be organized to accumulate all settlement costs expended on the claim. A common expedient is to assign a work order to this type of cost and have all direct and indirect workers present labor cost cards, or salaried employee time reports, charging the work order for time spent on any phase of the settlement proposal.

Oversight of Subcontractors' Claims

A subcontractor has no legal standing against the Government in a termination. His rights are directly against the prime contractor or the next higher

tier subcontractor, or whoever has issued the purchase order to him for work to be performed. Upon receipt of termination notice, the prime contractor is expected to serve notice to the subcontractors affected by the termination. Subcontractors are also expected to pass this notice on to the next lower tier. The prime contractor is expected to advise and assist the subcontractor in the preparation of his claim and is also expected to make all the necessary checks in order to determine the reasonableness of a claim, as would the government under similar circumstances. However, it should be pointed out that all claims of subcontractors are subject to the approval of the contracting officer. If the contracting officer is satisfied with the procedures used by a contractor in settling claims, he may authorize the contractor to make all settlements (but not to exceed $1,000 without prior approval).

The Claim Inventory; Disposal Problems

The claim inventory should be prepared for submission on the appropriate government schedules. Care should be taken to fully describe the inventory in accordance with the commercial description that would be adequate for disposal and screening purposes. If due care has been exercised, the company has taken a complete physical inventory of the material allocable to the terminated portion of the contract. The raw material, parts and work-in-process have been inventoried by the production control department and priced by the cost department. Open commitments have been manifested by production control and the outstanding purchase orders have been amended or cancelled by the procurement department, and the subcontractor and vendor's claims have been submitted and audited. Tools and test equipment, purchased or manufactured for the contract, representing company-acquired or government-furnished property have been inventoried by the cognizant department and a price fixed on items that the company has an interest in retaining.

Some portion of the termination inventory will be retained by the company by means of diversion. Other portions will be transferred to other governmental agencies. Another part will be sold. In the event the company agrees to purchase a certain part or all of the termination inventory, the amount agreed upon should be deducted from the claim as a disposal credit. If the company is authorized to dispose of the inventory, the amount received should be entered as a disposal credit. The government, in some cases, authorizes the company to destroy or abandon the inventory. That part of inventory which has no sale or scrap value may be donated. The contracting officer will review the recommendations of the company concerning scrap. Generally, when inventory is

disposed of or sold as scrap, a scrap warranty is expected by the government. The receipts from the scrap sales must be entered as a disposal credit on the settlement proposal.

Comptroller's Review of the Claim—And Government Audit

From the company viewpoint, assembly and approval of the claim is the responsibility of the comptroller's division and various questions should be answered before it is submitted. Some of these questions follow:

1. **Are inventories of completed units and assemblies, work-in-process and raw materials in proper order?**
2. **Have values and salvage been verified by responsible authority in the manufacturing division?**
3. **Have obligations to suppliers and unliquidated costs of the subcontractor been verified by the purchasing and production departments to the extent that claims arising from them may be approved and recommended for payment without audit of subcontractor records?**
4. **Have preparation and starting load costs and development and special engineering costs either been fully amortized during the progress of the contract, or included as a claim for unliquidated costs?**
5. **Is there a claim for unrecovered manufacturing or administrative costs identified with the contract?**
6. **What are the costs of obtaining discontinuance and settlement, including the post-termination charges, i.e., the cost of taking and evaluating the inventory time of employees working on special cancellation jobs, cost of waiting time, if any?**
7. **Are there any unexpired leases or other housing costs?**
8. **What are the storage charges applicable to inventories?**
9. **What are costs of protecting and preserving government property?**
10. **What are the costs for packing terminated materials?**

If all of the above questions are answered in the affirmative, the claim is ready for government audit.

All claims submitted by prime contractors are referred for audit by the contracting officer to the audit agency of the department concerned. The reports and recommendations of the audit agency are submitted to the contracting officer in writing and used as a guide in negotiating the final settlement. All settlements with subcontractors are submitted for approval to the contracting officer unless the contractor has authority to settle those claims not in excess of $1,000. The contracting officer submits all such claims received by him to his audit agency if such settlements involve $25,000 or more, or if he considers a partial audit or a complete one desirable.

All settlement proposals of prime and subcontractors submitted to contracting officers are also subject to the approval of a settlement review board at the field level. This is operative in the following instances: settlements involving $25,000 or more, settlements limited to adjustment of the fixed fee for a cost-type contract or subcontract where the total amount of fee exceeds $25,000.

The contracting officer may, at his discretion, desire his superiors to review the settlement decision. If the claim is in excess of $500,000, it is subject to the approval of the head of the procurement activity involved.

A government procedure for partial payment has been set up to handle requests for partial payments on termination claims. Where a contracting officer is of the opinion that the proposal of prime contractor or subcontractor is fair and reasonable and a preliminary review of the accounting data indicates that the application is proper, the contracting officer may authorize payment on a percentage basis, depending on the type of inventory. No partial payment for profit or fixed fee can be claimed under this method.

Determination of Profit Allowance

Profit or fee computation for a termination-claim is applicable only to costs incurred to the date of termination. If it is an inventory basis settlement proposal, the profit is computed as applicable to the company's costs clearly related to performance of the terminated portion of the contract. There is no profit allowable on settlement expenses, subcontractor's claims and interest on borrowings, when these are considered as an allowable item of cost. Subject to this limitation, any reasonable method may be used to arrive at a fair profit or fee. The basis could be what both parties agreed upon or contemplated at the time the contract was negotiated or what a company would have earned had the contract been completed or what a company may have agreed to accept in the event the contract was terminated.

One method of arriving at a fair profit or fee is to allow the same proportion of the dollar amount of the profit which both parties agreed upon, or contemplated at the time the contract was negotiated, as the work performed on the terminated portion of the contract bears to the work contemplated by the entire contract. This proportion does not necessarily depend on the ratio of the costs incurred on the terminated portion to the total estimated costs nor on the ratio of materials acquired for the terminated portion to the total materials needed. (For example, where the acquired materials have not all been processed, the government would feel that costs based on them are not a fair index of the proportion of the work done.) These factors should be considered, but the primary test of proportionate completion is the extent and difficulty of the work done, including engineering work, production planning, technical study and supervision, arrangement and supervision of subcontract, etc., as compared with the total work required by the contract.

Engineering estimates of the percentage of completion should not ordinarily

be required but could be properly considered if available. Where the contract has called for the arrangements of subcontracts and the supervision of their performance, this work should be considered in estimating the extent of completion. However, the profit or fee should not be measured by the amount of the company's payments to subcontractors for their termination claims.

In addition to points already mentioned, other factors should be considered which may exist in relation to the terminated portion of the contract. Among these are efficiency of the company, with particular regard to attainment of quantity and quality of production, reduction of costs, and economy in use of materials, facilities, and manpower. Additional considerations are inventive and development contributions and cooperation with the government and other contractors in supplying technical assistance. The character of the business, including source and nature of materials, complexity of manufacturing techniques, character and extent of subcontracting, and such other factors as fair and equitable dealing may require, should also be given weight in determining allowable profit. Profit is not a fact but a derivative of factors and, therefore, is solely a matter of negotiation with the contracting officer.

The contractor "pays" for his own losses. The government takes the position that if work on the terminated contract results in a loss or if it appears that the company would have suffered a loss had the contract been completed, no part of the loss on the completed portion of the contract should be considered as an item of cost and the amount of the claim should be reduced by the indicated rate of loss.

Concluding Termination

With the assistance of his audit recommendations, the contracting officer negotiates with the company a final settlement, giving due cognizance to the full range of factors to which this article has been devoted. At the conclusion of negotiation, he prepares a memorandum setting forth principal elements of the settlement, to be included in the contract file. Such settlements can be negotiated on an individual item basis or on a lump sum basis.

An appeal relating to a termination claim is handled as a dispute under a contract. The appeal would have to be filed with the appeal board. If the company has not submitted a timely termination claim, or obtained an extension, it may be precluded from exercising appeal rights.

PRODUCTIVITY MEASUREMENTS CAN BE OBTAINED AND USED

QUITE OFTEN WE SEE in newspapers or magazines that substantial increases in productivity have taken place in recent years. These advances are usually stated in terms of increases in output per man-hour. We may also read that a new labor contract has been signed, including provisions for wage increases based on general improvements in productivity. Despite our exposure to such easily-stated concepts of productivity, I doubt if many industrial accountants—whose everyday job it is to work at improving productivity—realize that these same measures may have some practical application to the problem of cost reporting. In fact, we might raise the question, do these blanket approaches to productivity measurement have any constructive relationship to the accountant's job of measuring the results of operating performance?

The answer to this question is "yes". Industrial accountants can measure changes in output per man-hour in their own companies, although the managerial usefulness of these measures is yet to be explored. In January, 1952, an article appeared in the *N.A.C.A. Bulletin*, written by William Langenberg, entitled, "An Experiment in Productivity Measurement," in which this problem is well discussed. The author of the article concludes that measures of productivity change are useful and he also illustrates a method which goes beyond measuring output per unit of labor alone and combines labor and capital inputs so the results of the combined factors of production can be measured.

In our company, also, we have recently experimented with productivity measurement. We are not fully satisfied with the results, but we feel that we have developed valuable information, even though we may not make such studies on a routine basis. In the division we chose to study first, we used labor alone as a base, because we wanted to see that result first and because labor was the predominant element of cost in this division. Both direct and indirect labor were included. The basic ratio we developed is as follows:

$$\text{Output per man-hour} = \frac{\text{Deflated production}}{\text{Total hours}}$$

This ratio was computed for each part of the study, i.e., for each of the selected number of years and converted to a series of index numbers using the first year as a base. Our regular cost and production records gave us almost all the data we needed to do the job, although several technical problems were involved in organizing the information. Our basic results, say, were three numbers—100, 98, and 108—indicating a drop in productivity and then a gain. Our real problem, though, was not so much to obtain a comprehensive measure of productivity and productivity changes as to explain, insofar as possible, the causes for the changes which

were revealed. To do this, we relied primarily upon the variance reports which are developed as a routine part of our cost accounting process.

First, we took the significant variances in each period and converted them to man-hour equivalents. Then, after developing man-hour equivalents for other variations in our operations, such as training and product mix, we re-computed the productivity and productivity indexes for each period, after eliminating any differences in the variances between the several periods involved. In principle, if we had found all the causes of productivity changes, our indexes would now be the same for each period, i.e., 100, 100, and 100. Actually, we found that they did come very close to each other. We could then re-tabulate the basic productivity results, setting forth the causes we had found to be responsible for the changes.

We plan to extend these studies and make further refinements. However, we feel that results to date point to the following conclusions:

1. Comprehensive measures of productivity are obtainable and the simplicity of the results makes such measures useful in reporting to management, especially top management personnel who are unfamiliar with the details of variance reports.

2. Since our variance reports isolate controllable variances at different levels of authority, it is convenient to put the operating performance record back together again in one piece and thus obtain more perspective about the trend of our performance.

3. Our cost accounting system, by this means, has been "audited" so to speak, in that with few exceptions, our variance classifications were adequate to explain the productivity changes which were discovered.

4. Long-range comparisons should be even more useful, because cost revisions tend to limit the possibility of comparing dollar variances of one year with those of another. The effect of major plant improvements can be more readily determined.

5. Both the productivity measures and the by-products of productivity studies, such as changes in value added, appear to be useful for industrial relations purposes and wage negotiations.

Another conclusion we came to in connection with this attempt at productivity measurement is that our standard costs really give us more information about productivity than can be obtained from studies such as these. At the same time, our standard cost results often leave some doubt in our minds as to over-all results which are being achieved and the basic trends in cost which are taking place.

We hope that studies along these lines will be made in other companies, so that we can all have a better base of experience to use to judge the meaning and usefulness of comprehensive productivity measurement.

JOHN H. KEMPSTER, *Boston Chapter*

Income Reporting and Price Re-Determination

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Looking primarily to "costs incurred or to be incurred" as a clue, even on negotiated contracts, as to what ultimate prices will be, the author of this article points out the necessity in three directions—financial statements, renegotiation, and Federal income taxes—for early near-final computation of revenue and associated costs on defense contracts subject to price redetermination.

LACK OF INTEREST ON THE PART of the great majority of accountants, in accounting for government contracts, leaves the "lonesome few" in the position of attempting to apply generally accepted accounting principles and practices to new situations without the benefit of the thinking and experience of the great body of industrial and professional accountants who are responsible for establishing and maintaining these principles. Furthermore, accountants who do have the experience of doing business with the Government, while prolific in covering specific problems such as allowable costs, types of contracts and facility accounting, seem reluctant to discuss the solutions they may have found to the problem of reporting income where prices are tentative, subject to change after the end of the fiscal period.

Let me briefly state the problem. A contractor, ready to close his books and release a financial statement for the fiscal period, finds that a substantial part of his sales are represented by deliveries under long-term contracts subject to price revision subsequent to the current year. How should income be recorded for the financial statements, for renegotiation, and for tax purposes?

Financial Statement Income and the Price Revision Problem

Three general solutions suggest themselves. First, do nothing. This is obviously no solution at all, since interim or other prices recorded on the books are merely a means of collection, with little or no relationship to what final prices may be expected to be. Or, collection may be by means of partial or progress payments, in which case no income has been recorded on deliveries. Under these circumstances, the financial statements must be qualified by notes indicating that no effort has been made to record income on this element of the business. A second alternative would be to record all sales at contract or bid

prices, ignoring any possible price adjustments until finally established. Here again, the reader of the financial statements is left to make his own guess without the benefit of the management's opinion regarding the significance of the income figures reported. The third approach, which is the subject of further discussion here, is to report income based on the best estimates available, clearly indicating in the statements the extent to which estimated price adjustments are included.

In finding a workable approach to "doing something," it may be taken into consideration that, basically, redeterminable sales will fall into one of the following classifications as of the end of the period being reported on:

1. Contracts on which redetermination proposals have been submitted but on which negotiations have not been concluded.
2. Contracts which are at or near the redetermination point but for which proposals have not been submitted.
3. Contracts in process which have not reached the formal redetermination point.
4. Contracts on which little or no experience is available.

Group 1 can properly be reported at prices proposed to the government and, in the case of Group 2, can be based on figures which will be proposed. This assumes that the proposals are realistic and do not include items for bargaining purposes only. If the latter situation exists, book prices should be reduced to the figure which the company's negotiators believe will finally be accepted by both the company and the Government. Group 3, contracts in process which have not reached the redetermination point, poses the greatest problem. However, assuming that production experience is sufficient to warrant a better judgment of the ultimate cost than was available at the time of bidding, an estimated revised price can be established. If, for Group 4, no better experience can be obtained than was available at the time of establishing the original contract price, it is obvious that these prices should not be adjusted.

Undue emphasis has often been placed on the distinction between cost-plus-fee contracts and negotiated fixed price contracts. Repeated lip-service is given to the concept that redeterminable fixed price contracts culminate in a negotiation of price, costs being merely one element to be considered in the establishment of this price. Government negotiators promptly rebuff suggestions that, in redetermination, they may be merely adding a percentage of profit to the total of acceptable costs. However, does experience bear out this premise?

As a practical matter, a contractor submits a redetermination proposal by accumulating all costs and expenses chargeable or allocable to the contract, and adding a profit factor to it. Assuming that an audit verifies the contrac-

tor's actual costs, the following items remain for consideration by the negotiators:

1. Reasonableness of estimates, assuming redetermination is made prior to completion.
2. Applicability of certain over-all costs and expenses prorated to the contract.
3. Other items set out by the auditor for further consideration.
4. Profit.

The first three items involve a determination of contract costs. Their resolution leaves only the matter of determining profit. From this point on, whether admitted by the negotiators or not, the problem resolves itself to the establishment of a profit factor to be added to cost in order to arrive at a selling price. At all events, whether or not this reasoning is entirely acceptable, the fact remains that a contractor with some experience in negotiating price revisions with the Government is in a position to estimate fairly accurately the final selling price of his product.

Applying Costs Against Estimated Contract Prices

Establishment of estimated sales for the fiscal period covered by the financial statement is one side of the problem. Another of the accountant's principal functions is the proper association of costs and expenses with revenues in order to present the most reliable estimate of the net results of operations. A determination of the costs to be recorded against estimated selling prices on contracts subject to price revision is, therefore, essential. This requires that costs, to be recorded against income, must be determined. Proper association does not just happen. A comparison of expenditures with billings is obviously no reflection of net income. This is most apparent in a situation in which deliveries are preceded by an extended period of development, start-up, and preproduction activity. Accepted practice in this instance would be to defer these initial costs, so that they may be absorbed against the income which is realized at a later date.

In spite of the difficulties, costs can appropriately be matched with income from redeterminable contracts. Recognizing that estimated selling prices have been established primarily from a review of costs incurred and to be incurred, it follows that the amount of cost to be absorbed against each dollar of sales has also been estimated. If a contractor determines that his manufacturing cost, based on experience to date, will be $100 per unit, that his administrative and other allocable expense will be 5 per cent of manufacturing cost, and that, in his best judgment, he will be able to negotiate a profit of 10 per cent of this total, he has a formula by which to estimate sales ($115) and manufacturing cost ($100) for each unit delivered. Variations in the formula may be required

where the contract provides for maximum prices, redetermination downward only, or incentive pricing. For example, if, in the above instance, the maximum price is $110, obviously an increase beyond that amount would not be justified, regardless of cost experience.

It is recognized that the results obtained under this method of pricing and costing redeterminable contracts are no more reliable than the ability of the contractor to evaluate actual cost experience and estimate costs to be incurred to completion. Further, even though manufacturing costs are estimated with a high degree of accuracy, changes in administrative expenses and other allocable factors between the time prices are estimated and their final determination can materially effect the results.

However, it is felt that judicious use of such estimating techniques presents the financial position of a contractor, faced with the problems of price revision, more clearly than other alternatives.

In effect, the management must make a decision on the matter. Lack of a positive action is a decision to reflect income on whatever basis recorded, without adjustment. Failure to act is not necessarily the more conservative position as sometimes presumed. It should also be emphasized that, once the program outlined is embarked upon, a constant review of prices and costs in the face of changing conditions, with appropriate adjustments, is called for.

Subcontracts Related to Prime Contracts Subject to Revision

Normally, a contractor whose prime contracts are subject to price revision will have let subcontracts on the same basis. It follows that these redeterminable subcontract prices must be considered in establishing estimated revised prices and costs under the prime contracts. The most important consideration in this connection is the recording of liabilities to subcontractors consistent with the cost of these subcontracted items included in the price of the prime contract. Where a subcontractor's proposal indicates that his price will be substantially different from the purchase order price, it may be desirable to include this difference in the prime contract price. If this is done, it is essential that costs and liability to the subcontractor be adjusted accordingly.

The question of when to recognize an adjustment in subcontract prices introduces problems similar to those involved in prime contract pricing. The steps in subcontract repricing are:

1. Submission of a proposal by the subcontractor.
2. Audit of the proposal either by the prime contractor or the Government.
3. Negotiation of a price.
4. Amendment of the purchase order.

It is clear that the degree of certainty with respect to these subcontract prices

will vary directly with the extent to which proceedings relating to them have progressed through these steps. Judgment and experience with individual subcontractors must form the basis for determining at what point price changes should be reflected on the books.

Renegotiation and Price Revision

The need for proper association of revenues with costs and expenses by fiscal periods is nowhere more apparent than in renegotiation proceedings. The one-way street of turning over "excessive" profits in a high-profit fiscal year, while being unable to recoup in a low profit period, should make this obvious. It follows, therefore, that, where contracts with price revision clauses represent a substantial part of sales, estimates must be made. The renegotiation regulations recognize this to the extent of allowing the inclusion of estimated price revision adjustments in renegotiable sales. However, the pitfall in renegotiation, as it pertains to price revision, is the requirement contained in final settlement of a particular year's proceedings by which the contractor agrees to report, and turn over to the renegotiation board as additional excessive profits, any amounts received which were not included in renegotiable sales for that year.

This provision would apparently require a company realizing a price increase subsequent to determination of the renegotiation refund and in the absence of a special agreement, to turn over the entire amount. Such a position must be based on the unwarranted assumption that costs are automatically recorded in the proper period and that, consequently, a retroactive adjustment in price represents additional profit for the period. It ignores the fact that the price increases are ordinarily granted because costs increased and that the effect on a prior year's net income is only the difference between the increase in selling price and the increase in cost applicable to shipments in that period. From this analysis of the situation, it is clear that a company holding contracts subject to price revision has every reason to try to anticipate the effect of possible subsequent price increases on its renegotiable sales.

Tax Reporting of Defense Contract Income

Income reporting for tax purposes, being based on law, is notably inflexible. The process of incorporating generally-accepted accounting principles and practices into tax reporting, with particular reference to new applications, is a long one and requires overwhelming support for any concessions won. It is paradoxical that anything in the nature of an estimate or reserve is contemplated with suspicion by the Bureau, when this attitude is considered against the background that all accounting statements are estimates of varying exactitude.

The reporting of price revision adjustments for tax purposes is covered in Revenue Rule 53 and related regulations and cases. Revenue Rule 53 specifically requires that downward price adjustments be excluded until they are finally "determined or repaid." These price adjustments are defined as a renegotiation. This apparently means that a taxpayer includes the full amount of deliveries at contract prices in the year or years in which shipments are made and then, when the prices are finally determined, pays the procuring agency a net refund after deducting a credit for taxes paid. This procedure is identical to the treatment of a renegotiation refund. In the event that the price decrease is "determined or repaid" prior to filling the tax return for the year involved, it may be reflected in income for that year. The only apparent reprieve from Rule 53 is contained in the following quotation therefrom: ". . . unless upon the submission of all the facts and circumstances, permission is granted by the Commissioner for reporting income on a different basis."

Price increases, which are not mentioned in Revenue Rule 53, are to be handled under the regular rules of accrual of income for tax purposes. Such income is ordinarily included in the return for the taxable year in which the contract is modified to provide for increased prices.

Better Income Statements If Best Final Price Estimates Are Used

The purpose of these comments has been to focus more general attention on income reporting problems of a defense contractor. The solutions to these problems, although of particular importance to a limited number of companies, should be founded on generally accepted accounting principles and techniques, the application of which are of importance to all accountants. Two fundamental problems are present. First, is it possible to obtain reliable estimates of the ultimate prices which will be agreed to on contracts subject to price revision? Secondly, if such estimates can be made, to what exent may they be reflected in the company's financial statements?

In answer to the first question, it is believed that, where a contractor has had some experience in negotiating prices with contracting agencies and maintains cost records satisfactory for the accumulation of contract costs, he is in a position to prepare estimates of revised contract prices which will more clearly present his financial position for the accounting period. As to the second question, it is the writer's conclusion that the use of such estimates, properly identified and segregated in the financial statements, presents a better statement of operating results than is available when the omission of such information is excused by a footnote to the effect that the management is unable or unwilling, to evaluate the probable effect of price redetermination.

Accounting for Cost-Plus-Fixed-Fee Contracts

by W. L. NEIMAN

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This well-illustrated paper gives roughly equal space to three sides of its subject: the accumulation of costs against individual contracts, keeping management informed through reports on how these "ventures" in the contract field are turning out for the company, and the derivation of overhead rates for departmental and general expenses. It is pointed out that CPFF contracts, although possibly of diverse use, have their special place as related to development work conducted by suppliers of the Government.

ALTHOUGH, FOLLOWING WORLD WAR II, there was a decline in the number of cost-plus-fixed-fee contracts entered into by the Government, a substantial number of CPFF contracts are still being issued for experimental, research and development work, to companies engaged in the production of items which are used by the Government. CPFF contracts are definitely not a "gravy train." They offer a relatively low rate of return, based on a rather narrow concept of cost, and, incidentally, require a considerable amount of detailed record keeping. They do offer one advantage. The contractor as well as the Government benefits from the knowledge acquired in the performance of the contract.

CPFF contracts can and do involve the expenditure of quite a sizable amount of money. That alone creates a situation worthy of discussion. More than that, recovery of expenditures is dependent upon the Government's interpretation of cost as set out in Section XV of the Armed Service Procurement Regulation. When a contractor enters into an agreement with the Government, he agrees to play the game according to the rules. With this in mind, an attempt will be made to describe in some detail a system set up to suitably handle the accounting for CPFF contracts.

Accumulation of Cost

This system will be discussed in three phases:

1. Build up of costs for ultimate invoicing.
2. Reports to management concerning the contracts and their progress.
3. Computation of a negotiated overhead rate.

The cost collecting vehicles employed at the Collins Radio Company

serve to illustrate cost accumulation procedure. A sales job order (SJO) is written to accumulate all costs against a particular contract, and an engineering project number is assigned to cover each phase of activity under the contract. In addition, an equipment and facility order is written to cover cost incident to the building of a fixed asset not a part of the end product called for in the contract. (This becomes a government-owned piece of property. Completion of this type of order requires setting up the necessary property accounting records.) These cost "vehicles" then "transport" the charges to the following cost-plus-fixed-fee sales-job-order in-process accounts:

A/C 371—Material—Beginning balance.
A/C 372—Material—Additions.
A/C 373—Material—Transferred to cost of sales.
A/C 374—Labor—Beginning balance.
A/C 375—Labor—Additions.
A/C 376—Labor—Transferred to cost of sales.
A/C 377—Overhead—Beginning balance.
A/C 378—Overhead—Additions.
A/C 379—Overhead—Transferred to cost of sales.

The accumulation of charges in the additions accounts (372,375,378) is the basis for monthly billings. The balances in these ledger accounts are supported by a listing of charges to individual sales job orders and engineering projects. In the case of our company, it is a tabulating report. However, it could be maintained manually if machine accounting was not available. A summary of cost is prepared from the listing and maintained in contract cost folders. The form in the cost folder sets out these charges by the element of cost indicated below, with dollar amounts and group totals opposite each:

Material
  Direct purchases
  Stores issues
    Total material
  Purchase price variation
Labor
  Publications
  Laboratory assistants
  Engineering development
  Drafting
    Total labor
Overhead
  Publications
  Laboratory assistants
  Engineering development
  Drafting
    Total overhead
Other costs
  Travel
  Flight-time
  Overtime premium
    Total other costs
Sub-total
Fixed Fee
Total billing

Issues from stores to CPFF contracts create an accounting problem which calls for special treatment because these issues are made at standard, and the Government must be charged at actual. We have a relatively simple solution for this. The issues create a need for additional purchases to replenish stock. The purchase orders written for this purpose carry the CPFF engineering project number and also the stock account number in order to distinguish them from

direct purchases on a CPFF contract. The difference between the actual cost shown on the vendors invoice related to the above purchase order and the standard cost, is listed by contract and presented to the audit agency along with the billing. If the standards in use are realistic, the differences between them and the purchase price are not significant. However, an increased volume of these transactions indicates that the engineering division may wish to review its buying policies, so that parts required on CPFF contracts may be acquired as direct purchases and, thus, more clearly identified with contract work.

Many items of cost generally treated as part of overhead may be charged directly to CPFF contracts. The number and types of these items depends on the contractor's accounting system and the attitude of the audit agency. Overtime premium, special tooling, starting load cost, special packing and travel expense could fall into this category. A truer picture of actual cost may be attained by making as many of these items direct charges as feasible. However, several problems may arise due to this treatment. For instance, the audit agency is going to exclude all similar cost in the overhead pool and, if the contractor cannot directly charge all appropriate expense of a particular category, he may stand to lose.

An example might be overtime premium on indirect labor. Such an expense would be an allowable cost if the contract provides for overtime premium but it does not lend itself to being charged directly to a job. An apparent solution would seem to be the inclusion of overtime premium on indirect labor in the overhead pool but, if the rates developed are applied to direct labor on a contract not authorizing overtime premium, such an approach would be denied by the audit agency. This problem might be solved in another manner, i.e., development of a ratio between the overtime premium paid to indirect labor and overtime premium paid to direct labor. Application of this percentage to the direct labor premium dollars charged to a contract would result in the inclusion of indirect overtime premium on only those contracts authorizing this charge.

The standard contract provision relating to state and local direct taxes provides that the contractor will not be reimbursed for any payment of such taxes. To escape payment of such taxes himself, the contractor should apply for a tax exemption certificate.

Billings—and Their Backing

With cost information available and in agreement with the ledger, the billing on CPFF contracts is made from the individual contract cost folders. The data is transcribed and presented to the government on the following forms:

1. Form 1035—Public Voucher for Purchases, and Services Other Than Personal—Continuation Sheet.
2. Contractors Statement of Cost—(showing this month's cost and fee, and cost and fee to date).
3. Contractor's Invoice—(prepared from the information on the statement of cost).
4. Form 1034—Public Voucher for Purchases, and Services Other Than Personal—(This form is primarily for the use of the government. The contractor is concerned only with filling in the correct contract number, appropriation symbols, assignee if any, and period in which costs were incurred.)

To this point, we have discussed the orders which are issued when a contract is accepted, the accounts in which cost totals are built up, and the folder detail maintained for billing (and other) purposes. It is now in order to discuss the documentary support which must accompany billings.

Most of the charges for materials are direct purchases. Direct purchases are items acquired for a specific CPFF project and are chargeable to the Government immediately upon payment of the vendor's invoice. The purchase order placed to procure these items indicates the CPFF engineering project and the material additions in-process account number. The original copy of the vendor's invoice must be sent to the department responsible for CPFF contract accounting. These invoices are then submitted to the audit agency in support of the billing for direct purchases. A listing of the issues from stores, indicating the part number, date issued, quantity, standard cost, and serial number of the parts requisition will suffice for documentary evidence to support the stores issues billing.

To substantiate the billing for direct labor on each contract, a listing is made setting out the employees clock number, hours, and amount charged to each contract. The Government is already in possession of the hourly rate of pay of each employee and spot checks can be conducted as frequently as desired.

There are, of course, numerous other categories, some of which need special types of support. For example, travel expense must be supported by individual expense vouchers. Also, purchase price variation and overtime premium must be confirmed by reports setting out these charges as such. These last two items have been given further consideration previously.

Not all of the above costs, as billed to the Government, will be honored with immediate payment. Some of the items will be suspended by the audit agency. All items suspended are to be considered collectable at a later date, usually contingent upon the receipt of a contract amendment authorizing them as charges. An example might be over-run on contract appropriation. A record of these suspensions is maintained, by contract, in a suspensions folder. This record indicates the amount, reason, and date of the suspensions. When a contract amendment is received relating to them, these items are resubmitted for payment and this fact is noted in the folder.

On the books, these billable costs are collected for the period of a month before they are invoiced to the Government. However, since the Government, when it grants a CPFF contract, agrees to repay the contractor for all allowable costs incurred in the performance of this contract, a receivable exists the moment any allowable cost is incurred, even though the invoicing does not take place until the following fiscal period. Hence, for financial statement purposes, it is better to classify the CPFF work-in-process plus the fixed fee on it as a receivable rather than an inventory item. Monthly entries effecting this are made, charging an unbilled balance account and credit accrued sales, at the same time charging accrued cost of sales and crediting CPFF sales job orders in process.

A reversal is made in the next period, at which time the actual invoicing and costing-out supplant the accrual and reversal. (The maintenance of such an accrual system may not be justified if the amount of money involved is small).

Reports to Management on CPFF Contracts and Their Progress

There are three major reports prepared by the engineering cost section at our company in conjunction with the accounting for CPFF contracts. They are described here in the following order:

1. Cost-Plus-Fixed-Fee Status Report.
2. Analysis of Profit and Loss on CPFF Contracts.
3. Analysis of CPFF Accounts Receivable.

The status report bears on needs for additional funds. It is imperative that the contractor know at all times the cost expended on each CPFF contract in relation to the total appropriation granted, since the expenditures are based on a cost estimate and additional funds may be granted if sought in time. Most contracts require that the contractor request additional appropriations sixty days in advance of the time they are going to be needed. The Government prefers that it be done ninety days in advance. This means that the contractor must know from 120 to 150 days in advance, so that he may have ample time to arrive at a new estimate of cost to complete the work.

Here is one way in which the status report is helpful. It conveys the status of CPFF contracts (dollar-wise) to management. This report is issued in two sections, with headings as follows:

Section I—Comparison of Cost and Fee Expended with Appropriation—by Contract

Contract	Sales Job Order	Completion Date	Total Appropriation	Cost & Fee Expended	Appropr. Balance	Purch. Commitments	Unexpended Balance
xx-xxxx	xxx	12-31-54	109,654.84	87,065.93	22,588.91	1051.00	21,537.91

Section 2—Accumulation of Invoiced Charges to Date—by Contract

Contract	SJO	Total Cost and Fee Expended	Material	Labor	Burden	Other Costs	Fixed Fee	Hold-Back of Fee
xx-xxxx	xxx	87,065.37	21,095.37	30,654.33	29,010.33	610.00	5126.31	569.59

The appropriation figure and the completion date on each contract, called by Section 1, are kept current through constant inter-change of information between the contract administrator and the supervisor of the section responsible for this report. The inclusion of outstanding purchase commitments helps to give a more realistic unexpended appropriation balance.

The figures for the status report come directly from the contractor's statement of cost previously mentioned. In this connection, it might be well to mention that the total invoiced cost will not of a necessity equal the cost of sales shown in the profit and loss statement. The reason is that invoiced costs would not include costs of the contract not collectable per contract stipulations (or lack of them). It is usually necessary to footnote this report to indicate contracts on which application has already been made for additional funds, extension of completion date, or both.

It is difficult to present a general explanation of the fee holdback identified in the last column of the report, because of varying contract stipulations. Some contracts demand immediate total holdback while others merely stipulate that the billing of fee be accomplished at a rate of 90% of the rate of fee (e.g., rate of fee 7% less 10% = 6.3% billing rate). The amount thus held back from billing is, however, included in the accrual of CPFF sales for a given month. Justification for this procedure is found in the probable action to be taken if the contract were terminated. Fee would most likely be granted to the contractor at seven per cent of costs to date.

It will be noted above that information on commitments is included in the report. Outstanding purchase commitments on CPFF contracts are direct purchases ordered but not yet received. These items become important because of the fact that parts required on CPFF contracts are quite frequently not regular items carried by the vendor. Therefore, a considerable lapse of time exists between the placing of the order and receipt of the goods. Maintenance of this type of information contributes materially to the knowledge of the status of each contract in relation to the appropriation balance the contractor has to work with.

An analysis of profit or loss on each contract is also helpful for management. The data supplied is from the inception of the job, for purposes of analysis, and for the fiscal year-to-date and monthly, for accounting and financial purposes. The information is reported under the following headings:

Contract	Inception-to-Date Sales	Profit	%	Year-to-Date Sales	Profit	Sales	Month of Cost of Sales	Profit

For this report, there is needed a set of work papers building up the sales, cost of sales, and subsequent profit in the manner shown below:

Sales	Contract A	Contract B
Reversal of last month's accrual	(10.00)	
This month's invoiced sales	9.90	
This month's accrual	12.00	
Special journal entries	—	
Total sales	11.90	
Cost of Sales:		
Reversal of last month's accrual	(9.15)	
Costing out of last month's cost	9.15	
This month's accrual	11.25	
Special journal entries**	.60	
Total Cost of Sales	11.85	
Profit or (loss)		

**This amount could be over-time premium incurred on CPFF contracts not authorizing such a charge. Hence, the item would be a proper cost of sales but would not be included in the accrual of cost of sales, which directly affects the amount of the sales accrual.

The third principal report developed on CPFF contracts is an analysis of CPFF accounts receivable. Such an analysis is necessary to keep track of the costs which may be suspended under audit, as previously described. The report also serves as a means of aging the receivables. Its headings appear below:

Contract	Sales Job Order	Accounts Receivable	Receivables Currently Collectible Month 1	Month 2	Month 3	Prior to Month 3

Contract Reserve	Fixed Fee Suspended	Excess of Allowable Costs Over-Billed	Overhead Suspended

The receivables thus shown by months for the purpose of this report do not necessarily coincide with the billing for the month, because these receivables do not include suspensions. The aging in this report sets out the receivables upon which payment may be expected currently, as distinguished from suspended amounts which require clarification or specific authorization before they can be paid. (Whenever a suspended item of cost is re-submitted by the contractor, it is moved from the suspension column to the month in which it was originally billed. The suspension column must always be in complete accord

with the suspension folder which, as pointed out earlier, lists such items by contract.)

A large balance in the "prior to month 3" column of the report indicates that there is a hold-up of payment and that some investigation on the part of the contractor may clear it up. Since, as stated above, these receivables do not contain the suspensions, such a build-up of unpaid receivables cannot be laid to anything but tardy payment of invoices.

Computation of Overhead Rates

To effect a good set of departmental overhead rates to be used on CPFF contracts, it is essential to localize overhead in three ways: by class of overhead, by cost center under class, and by account number indicating the type of expense. An over-simplified illustration of how expense is accumulated at our company is shown in Exhibit 1. To illustrate departmental overhead rate development, our engineering division will serve. This division performs labor on three types of projects. They are CPFF projects, engineering projects related to other specific sales, and Collins-sponsored research and development projects. The total labor expended in connection with these three types of projects becomes the direct labor base over which the total engineering overhead pool is to be spread.

Three basic types of adjustments must be made to the overhead pool for the purposes of developing departmental rates. First, because the material and labor expended in connection with Collins-sponsored projects is classified as overhead on the books, it is necessary to exclude the former and transfer the latter to the direct labor base, to leave a balance in this classification representing overhead for contract purposes. Secondly, charges, such as overtime premium, which are treated as direct charges to the contract, must be eliminated from the overhead pool. In the third place, expenses specifically denied by Section XV of the A.S.P.R. must be excluded. In connection with this, it is well to give emphasis to a proper and complete break-down of expenses by the contractor's account classification. This is especially important because of the existing attitude on the part of the Government that, if an expense cannot be broken out as an allowable type of cost, it may be ruled unallowable by virtue of the fact that it is a conglomerate of overhead which, although it may be of a similar nature, is not identical for the purposes of determining allowability.

The following list of eliminations from overhead particularize the adjustments referred to above:

EXHIBIT 1

SUMMARY OVERHEAD EXPENSE CLASSIFICATIONS

ACCOUNT	MANUFACTURING DEPARTMENTS		ENGINEERING DEPARTMENTS			ADMINISTRATION DEPARTMENTS		SELLING DEPARTMENTS	
	Assembly	Test	Specification	Model Shop	Drafting	Acctng.	Systems	Advertising	Contract Administration
Salaries									
Salaries transferred to D.L.									
Indirect Labor and Clerical									
Supplies									
Outside Services									
Utilities									
Telephone and Telegraph									
Postage									
Travel									
Transportation									
Professional Service									
Advertising									
Dues and Subscription									
Donations									
Insurance									
Taxes									
Rentals									
Amor. of Emergency Facilities									
Depreciation									
Amortization--Intangible									
General Expense									

1. Eliminate from overhead salaries charged to Collins-sponsored development and research, which are classified as overhead per the books but which become part of the direct labor base in figuring CPFF overhead rates.
2. For the same reason, eliminate from overhead wages charged to engineering development work, also all overtime premium, since it is charged directly to the contract.
3. Eliminate from overhead supplies charged to engineering development.
4. Adjust travel for any entertainment expense, since it is specifically denied on government contracts. Also remove all travel expense except that of engineering supervisory personnel, since it is charged directly.
5. Eliminate from overhead all freight out, since, if such charges were incurred on a CPFF contract, they would be made as direct charges.
6. Eliminate legal services from overhead as they are a type of cost specifically denied.
7. Eliminate goodwill, publications, direct mail and sales bulletins.
8. Eliminate donations, as they are specifically denied.
9. Eliminate premiums paid on officers' life insurance policies.
10. Adjust amortization of emergency facilities to a true depreciation figure.
11. Eliminate all amortization of intangibles.

The total adjusted overhead pool is then divided by the direct labor base to arrive at a rate for each department. The direct labor base consists of engineering salaries and wages charged to direct labor, plus engineering salaries and wages charged to Collins-sponsored development and research, transferred from book overhead, as previously described. The computation yields the departmental overhead rates to be negotiated for.

All direct elements of cost on CPFF contracts have now been covered for the purposes of this paper, and the element of indirect engineering expense has been included through description of the development of departmental engineering overhead rates. The cost of general, administrative, and selling expense applicable to cost-plus-fixed-fee business is now to be taken up. Just as the proper account classification is so important in regard to departmental overhead rates, so is the proper classification of departments of great significance in determining the general and administrative rate. Some of the departments are not concerned with CPFF contracts at all. This would exclude such departments as industrial sales, market research, and advertising. Expense of the remaining departments, such as contract administration, accounting, systems, and general administration are considered to be allowable cost, but certain of the expenses incurred in these departments must be excluded to conform with the definitions of allowable cost in Section XV of the A.S.P.R. These exclusions are basically of the same nature as those which have been described in connection with the development of departmental rates.

Cost of production, or cost of sales are the alternative bases recommended by the Cost Inspection Service for allocation of General and Administrative expenses (preference is in that order). However, under our accounting system, the adoption of either of these methods would result in inequities to the contractor. Therefore, a special procedure has been devised. As a first step, general, administrative, and selling expenses are allocated to engineering on the basis of the relationship between engineering direct labor hours and total manufacturing and engineering direct labor hours. A percentage is then calculated, based on the relationship between engineering's pro rata share of general, administrative, and selling expense and total engineering direct labor dollars. This percentage is added to the departmental rate and applied to each direct labor dollar charged to an engineering project related to a CPFF contract.

The cost survey conducted in connection with both departmental and general and administrative rates is a study of the actual expense incurred in a previous six month period. It is repeated every six months in order that a new set of rates may be negotiated. This study of past history cannot, of itself, take into

consideration circumstances which might be peculiar to the coming six months. Knowledge of any such future circumstances should be noted in arriving at a set of rates which will be most appropriate to the coming period. An example of such a circumstance might be a pay increase to be effective in the coming six months.

In the survey of the past six months costs to arrive at new burden rates, it may be found that the contractor sustained a loss due to application, to the period studied, or rates based on the six months previous to that. No adjustment can be made in the burden applied in the previous period, since the rates were negotiated by both parties in good faith. However, it is not the purpose of the government to force a contractor to suffer a loss on allowable overhead incurred. Therefore the effect of such losses should be included when negotiating a new set of rates.

Conclusion

It is this writer's experience that not all of the problems encountered in CPFF contracts can be anticipated. However, it is also his experience that discussion of these ever-arising situations with the audit agent of the government will provide a suitable solution. The course of action the contractor takes must be approved by the cost inspector, anyway, and discussion with him will avoid misunderstandings on the part of either. Better understanding of the contractor's individual problems helps the cost inspector make a more intelligent decision and he should be more than happy to discuss them.

This presentation of our practice, along with general considerations, in building up costs for invoicing, statements to management, and overhead rate computation, may be of some help to contractors engaged in CPFF contracts. As stated at the start, this type of contract has a definite usefulness, especially in the area of experimental and development work for the Government. On a long view, it may well be held that work of this character is on the increase, rather than otherwise. If so, reliable guides to its conduct continue to be needed.

Education for Cost Control: Round-Table Method

by CHARLES LAWRENCE

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The ten-member "split-level" group of employees of several companies, excluding "career cost accountants," which studied the why and how of cost control under the auspices of an education institution, as described in this article, exemplified an approach to the subject which, in the view of the author, offers potential benefits up and down the line of operational responsibility. These benefits lead in the direction of making cost control a unified company effort. It is noted that the discussion group idea may be variously applied.

PROGRESSIVE INDUSTRIAL EDUCATION should not be limited solely to empirical experience but should include aspects of training with which to widen basic practical knowledge. An excellent field for the application of this fuller concept of training is in the field of cost control. Successful cost control programs are only as sound as the general understanding of the reasons for their existence. The process of bringing plant-wide cost control education to a satisfactory level is a complex one, each phase of which deserves full consideration. Perhaps in no other area of industrial activity is widespread company personnel understanding as necessary as in the successful application of cost control measures.

In spite of this, a common characteristic of cost control discussion groups has been the tendency to limit them to personnel directly concerned with technical aspects, i.e., persons closely allied with the accounting end of the program. Limitation of the educational group in this manner has advantages in that terminology, background, and general level of understanding are not serious problems. In these groups, an understanding of the relationship of cost accounting to cost control, of cost accounting reports to final financial statements, and of the cost accounting department's role to the rest of the factory's departments are all taken more or less for granted. They do not appear as problems, either in a technical way or in intergroup relations.

However, there are many nonaccounting personnel in the plant who also might profitably be made aware of the relationships which the cost accountant takes for granted. There are several basic reasons for such a suggestion. First, it is a well known academic principle that a person who understands the reasons for his actions does a better job. For instance, linking cost accounting both with cost control as a plant operating policy and also with an individual's own job tends to make cost control rules and regulations more palatable.

Second, as a practical matter, cost control is effected primarily by the nonaccounting personnel of the plant and not by the technical accounting staff, themselves. Although the accounting process isolates certain matters for attention and control, the individuals who furnish the basic data and those who make or break cost control measures are generally located in other than the accounting offices of the operation concerned. Cooperation must be secured from all the factory personnel if cost control measures are to be effective. Thus, the matter of conducting semitechnical discussion sessions with nonaccounting personnel is a practical, but often overlooked, aspect of a cost control educational program. The organization of such discussion groups is an available cost control tool the usefulness of which should be recognized more widely. The beneficial result which reasonably can be expected is the increased understanding and appreciation of cost control procedures, obtained through a simplified explanation of basic cost control concepts.

Composition and Goals of One Discussion Group

The experience of one such discussion group seems to bear out the foregoing explanations and may well warrant discussion of the mechanics of its program. The organizational plan, subject taken up, length of time and composition of the group are matters which will vary with the situation. This particular group met in a two-hour session one night a week for an eight-week period. The program was launched through the cooperation of the local college and several of the manufacturing firms of the area. The supporting educational institution furnished a member of the cost accounting staff as a moderator and also drew up a preliminary statement of the general objectives of the course. The group as finally constituted was composed of ten persons representing three manufacturing firms. Three participants were of plant managerial level, three were electrical engineers (in the design section of one of the companies represented), two were cost estimators, and two were beginning cost clerks. This group had opinions about, and experiences with three different companies' operations from nearly every angle but that of a career cost accountant. These were carefully screened from the group so that participants could take part in the group discussion without feeling embarrassed by a lack of formal accounting knowledge. All were interested in learning more of the results and effects of their individual efforts upon cost control figures.

In view of the background of the personnel of the proposed group, the course study plan was designed to bring under examination certain basic ideas relating to cost control and cost accounting aspects of a control program. It was not

designed to solve any specific control problems in other than a general way and it did not purport to be a complete training course in cost accounting. The most important aspect of the discussion program was the building of a forum in which the nature, relationship to, and effect of certain cost situations to the people concerned were to be examined. Therefore, the outline was drawn up so as to indicate that:

1. Cost control techniques and procedures were to be subject to examination by nonaccountants.

2. Emphasis was to be placed upon the relationship of these procedures both to the individuals concerned and to the resulting financial statements and reports.

Nature of Proceedings and Sequence of Topics

The program set up followed, in a general way, the points listed in Exhibit 1. It must be remembered that the coverage was not at all complete in an accounting sense but was designed to relate cost control measures both to the individual's job and to the results of his actions as reflected in the company cost records. The background for discussion was laid by the moderator in a series of sessions furnishing basic cost accounting ideas to the group. The purpose of these introductory lectures was to furnish a common background around which future cost discussions could be built. These beginning lectures considered the usefulness of the cost accounting approach, the nature of the elements involved in costing, and the development of historical cost accounting methods.

As the course progressed, the lectures were supplemented by in-session laboratory problems involving the handling of the basic ideas presented. These problems were not presented so much from an accounting viewpoint as to relate hypothetical factory situations with which the discussion participants were acquainted to financial statements and reports of the company. The "T" account was the only "new accounting device" used to bring the discussions to a point of common understanding.

In the later sessions of the course, group discussions were encouraged on the effects of given situations upon each of the individuals represented. Such discussions were related as nearly as possible to the basic objective of control of costs. As the underlying ideas became familiar, the concept of the use of a standard in controlling costs was introduced and also the principle of management through inspecting deviations from such a proposed standard. In this latter stage, interesting and informative discussions were stimulated by having a "guest" cost accountant of a represented firm bring to the group some of his company's basic thinking on standard setting. The presentation included description of a method of accomplishing a certain phase of cost control. The

COST CONTROL DISCUSSION PROGRAM BY SESSIONS

Session 1.

a. Introduction of individuals, with brief background sketch of each.
b. Comparison of general accounting with cost accounting results in simple examples, emphasizing the advantage of determining accurate costs for both regulatory and competitive reasons.

Session 2.

a. General terminology review session, with examination of terms usually used in dealing with cost accounting. (Comparison and investigation of the different terms used in each plant for identical elements brought about a smoother means of communication in later sessions.)
b. Brief discussion of the three elements of cost.
c. The concept of historical costs, including a simplified presentation of the flow of costs through a hypothetical factory.

Session 3.

a. Historical costs compared to other types of forecast costs, such as standard costs and the relationship of the two types of costs to control measures.
b. Consideration of the relationship of standards or goals to cost controls.

Session 4.

a. Consideration of control measures in the material and labor areas, including an examination of the means of control.
b. Consideration of the third element in costing, including a sample element to consider, "What is the effect of variations of capacity on indirect cost control?"

Session 5.

a. Consideration of operating budgets as related to goals.
b. Relationship of goals, standards and budgets.
c. Consideration of various examples of variances in the three elements of cost. Isolation of variances. Methods of finding causes.

Session 6.

a. Further special problems in the element of indirect costs, such as overtime, vacation pay, strike effects, and inefficiencies.
b. Inter-relationship of cost standards, cost accounting reports, and cost control.
c. Presentation of usefulness of cost accounting department and its proper relationship to other departments of the plant.

Session 7.

a. Study of various cost forms and reports with which the group is familiar. Other reports of a cost control nature and a review of the general principle of management by exception, as related to cost control.
b. Introductory discussion of what standards are used in "your" plant.
c. Discussion of how standards were and are set in "your" plant.

Session 8.

a. Review and summary of methods used in, need for, and application of cost control in the given plants and on the jobs represented.

EXHIBIT 1

group then was in a position to give a rather rough and ready appraisal of the method. Again, it should be mentioned that the group was not constituted for the purpose of solving—nor was it able to solve—any cost control problems but had as a primary goal the stirring of interest in, and the spreading of knowledge about, cost accounting and, more particularly, cost control.

The final sessions of this particular group centered about the implementation of cost controls with reports, a subject which it was more possible to present clearly after a brief study of the ideas involved in standard costing. The relation of control to statements, of the coordination of physical movement in the plant with accounting figures appearing later in statement form, and the actions which might be taken as a result of these statements, were some of the major matters considered at this point, to awaken in the participants some realization of the final results of their individual actions.

A Better Understanding of Means to Cost Control

The general rewards of such a discussion group course are threefold. First, a number of deep-seated "gripes" about cost control methods or procedures are aired in an impartial atmosphere. For instance, one engineer rather aggressively inquired as to "Why should the cost accounting department be a watchdog over my department?" The answer developed, perhaps, was not enough to overcome his prejudices but gave him a chance to get it off his chest and to receive a reasonable, impartial reply to his inquiry. (The men in his own cost department might be slightly aggrieved at such a blunt approach to this question.) Second, some of the confusion caused by accounting terminology was ironed out so that the persons on several levels could exchange ideas and be understood by persons with different backgrounds in the plant. And, third, by furnishing richer backgrounds for, and new viewpoints of, the cost accounting process to persons affected but not directly related to the accounting department, the ideal of cost control seemed to have been measurably furthered.

This was but one experiment, but it seemed in its own way to pay educational dividends to the persons concerned. It is believed that it is an effort worthy of wide repetition. The process of enlarging cost control appreciation and information by means of nonaccountant discussions on a small scale is worthy of due consideration in the development of any overall industrial cost educational program.

THE WORKSHOP

Use of Control Charts in Cost Control

by EDWIN W. GAYNOR

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Sampling to provide data both for charting of average deviation from standard and range of this deviation is explained and illustrated in this article. These two aspects are identified by their statistical symbols, $\bar{X}$ and R, respectively. In addition to the symbols mentioned, the terms "frequency distribution," "standard deviation," and control limits are made familiar to the reader and their usefulness in processing cost control data is spelled out. (Further application of the material contained in this paper is to be found in "Calculating Control Limits for Cost Control Data" by Carl E. Noble, which succeeds it in this issue of the N.A.C.A. Bulletin.*)*

IN RECENT YEARS, significant progress has been made in the application of statistical techniques to the solution of management problems. In this area, statistical quality control has developed some remarkable tools. Of the several which can be considered of value in the field of cost control, the technique of control charts appears to offer promising results. Here is a technique, which, although not a solution to all of our problems, can, if properly used, highlight weak points in a cost structure, not at the end of a month or year but during the actual opertaion if we so choose. Basically, it is a system of selective sampling. Its fundamental characteristic is the selection and evaluation of a periodic sample selected from the particular population the limits of which we are attempting to control. Its great merit lies in the fact that, by requiring these periodic samples to be taken, the technique reveals variations from a standard which might otherwise remain undetected.

What the $\bar{X}$ and R Charts Are

Among the many statistical quality control techniques which have been perfected, the development of the $\bar{X}$ (pronounced either X bar or bar X) or average and the R (range) charts ranks among the more important. It must be mentioned that this article is not a treatise on statistical methods. It assumes that basic statistical concepts need to be explained here only briefly. Detailed information can be

obtained by review of a standard statistical text or consultation with the company's quality control groups. The $\overline{X}$ and R charts measure the deviations from a given standard and offer a technique to determine whether the measurement being analyzed indicates a condition that is either "in control" or "out of control." By control, in this case, we mean statistical control, i.e., if the variability of our measurement is due to numerous causes as found in a normal distribution, we are in control. If, on the other hand, the variability is due to large assignable causes, the process is out of control and we begin to investigate the causes for this situation. Each of the two types of charts measures a different type of variability. The $\overline{X}$ chart measures the variability of the averages of the measurements within a given sample, while the R chart measures the variability of the range of the measurements within a given sample.

An Illustration of the Use of $\overline{X}$ and R Charts

Since the proof of any theory lies in its application, a reasonably realistic condition which lends itself to a solution, will best serve the present purpose. Assume that, for a specific operation, we have set five minutes as standard time of performance. These five minutes are a measure of time. Time represents money. If time can be controlled, cost can. This standard is considered as an average, that is, it is expected that some operations will be performed in four and three-quarter minutes while, at other times, the operation may take longer than five minutes. However, on a long range basis, a five-minute average is regarded as satisfactory performance.

Under conventional cost reporting methods periodic variances from the five-minute standard are not discovered until the end of the day or week, or not until production and standard time are compared at the end of a payroll period—or perhaps not at all. Usually, an average for a relatively long period of time is composed of a great many compensating plus and minus variances completely overlooked, simply because they are not apparent. However, with the method under discussion many deviations can be discerned very soon after they take place and immedate steps can be taken to prevent their recurrence.

The first step in establishing a statistical approach to the problem is an orderly and systematic array of factual data upon which a control pattern can be determined. In this case, a period of fifteen days was selected and an hourly comparison of acceptable production with performance hours was made. This provides knowledge of the average performance time per unit of good product. (The ideal method to obtain this may be time study on a per unit basis but, under certain circumstances, time study may create additional personnel problems and,

OBSERVED STANDARD TIME PER UNIT—FIFTEEN SAMPLES.

SAMPLE NUMBER	OBSERVATION WITHIN THE SAMPLE								$\bar{X}$ AVERAGE	$\bar{R}$ RANGE
	1	2	3	4	5	6	7	8		
1	6	5	5	4	5	4	6	5	5.000	2
2	6	6	7	5	7	5	4	5	5.625	3
3	5	5	4	7	6	5	3	5	5.000	4
4	6	6	5	4	7	7	7	5	5.875	3
5	4	6	6	7	8	4	5	5	5.625	4
6	5	4	8	5	3	5	4	5	4.875	5
7	3	5	5	5	6	7	5	6	5.250	4
8	6	6	6	5	5	4	5	5	5.250	2
9	8	7	5	5	6	7	3	6	5.875	5
10	5	5	5	6	7	5	5	5	5.375	2
11	5	6	6	5	7	6	5	5	5.625	2
12	5	6	5	5	7	6	5	3	5.250	4
13	4	5	4	6	5	6	6	5	5.125	2
14	5	4	4	7	6	5	4	5	5.000	3
15	5	5	4	6	6	6	4	5	5.125	2
									79.875	47

EXHIBIT 1

therefore, may not be desirable.) It will have been noted that comparison of performance time with good product is specified, since, in the final analysis, all time spent must be related to good product produced. Re-work, delays due to breakdown or material shortages, and many other unprovided-for incidents, all add to the cost of the finished product and, therefore, cannot be disregarded. They are the result of some assignable cause and, in turn, affect the cost to be controlled.

The sampling scheme suggested would result in a series of measurements such as those portrayed in Exhibit 1. Each of the measurements represents the time that it took to perform a specified operation at the time the sample was taken. The operation could be of any nature: drilling, boring, cutting, auditing and the processing invoices, preparing payrolls, or it could be the relationship between an element of cost and a specified unit of measurement of output or volume. In practice, where measurements become burdensome, it is customary to deal only with the deviations or variances from the prescribed standard. Our values are relatively simple, so we shall use the absolute measurements set forth.

After the data has been collected and tabulated in an orderly array, the average and range of each sample is calculated. The average is determined by adding the values of the individual observations and dividing by the number of observations taken. In the case of the sample taken on the third day, the average is calculated as follows:

Add:	5	
	5	
	4	
	7	Divide: 40 by 8
	6	
	5	Average: 5
	3	
	5	
Total:	40	

Since the range is the difference between the highest and lowest measurements within a given sample, its value is determined by subtracting the lesser of the two values from the greater. In the observations taken in the eleventh sample, the highest measurement making its appearance is seven and the lowest five. The difference betwen these values is the range of two. In a similar manner, the averages and the ranges are calculated for each of the fifteen samples.

To complete the required mathematical calculations for the solution of the problem there is required the values for the average of the averages ($\overline{\overline{X}}$) and the average of the ranges ($\overline{R}$). These are calculated as follows:

$$\overline{\overline{X}} = 79.875/15 = 5.325$$
$$\overline{R} = 47/15 = 3.13$$

What the Standard Deviation Is and Does

Beyond this point, there is one more concept to review, namely, standard deviation. In statistics, this is the term applied to the basic measurement of dispersion about the average. In this example, a normal distribution has been used. When charted, the data would follow a pattern very similar to the bell-shaped curve. When a frequency distribution is made of the data presented in Exhibit 1, a curve which reasonably approximates the normal is disclosed. Exhibit 2 is a graphic presentation of this distribution. As more data becomes available, it is quite probable that the distribution will approach the normal even more closely. But how does it happen that the standard deviation measures the dispersion of data about the average? It can be proven that, in any normal distribution, there will be the following dispersion of data about the average:

68% of the data will fall within + or — 1 standard deviation
95% of the data will fall within + or — 2 standard deviations
99.7% of the data will fall within + or — 3 standard deviations

The principal value to be derived from the use of this measurement is its ability to disclose where most of the data should fall under normal circumstances. If it is known that the average of a group of measurements is five, and the standard deviation is one, it is then known that 99.7% of the

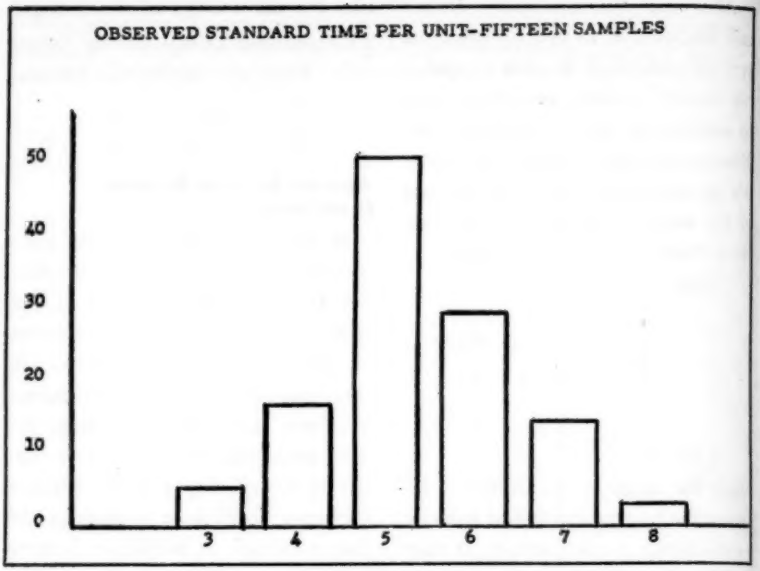

EXHIBIT 2

measurements should fall within 5 + or — 3 standard deviations, or from two to eight as shown below in Exhibit 3.

Therefore, if we take a sample the average of which is 10, we know that it falls outside these limits. It can be concluded that, either distribtution is not normal or some condition is causing an abnormal variation. "That is fine," one might say, "but what do we do with it?" Simply this. Through the technique being discussed it is possible to set upper and lower control limits. Any measurements falling within these limits are considered to be normal deviations and, therefore, the operation is in control. Deviations falling outside the control limits are considered to be due to some assignable cause and, therefore, indicate that the operation is out of control. The logical consequence of this conclusion is the investigation of the assignable cause to prevent repetition.

Control Limits and Their Use

We have now reached the point at which it is necessary to determine some values for the control limits already mentioned. Since 99.7% of the data will normally fall within three standard deviations, we decide that a set of limits based on this concept will be satisfactory. Determination of these limits is greatly simplified by the

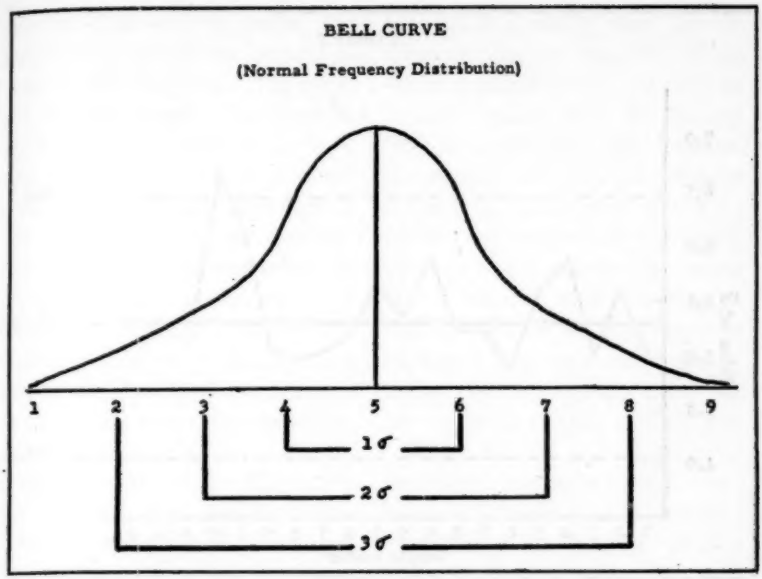

EXHIBIT 3

use of tables of "Factors for Determining from $\overline{R}$ 3 Sigma Control Limits for $\overline{X}$ and R Charts." These tables, as well as directions for their use, are included in many quality control texts. In our particular situation, the limits for $\overline{X}$ and R are calculated as follows:

With the calculation of the control limits the mathematics of the problem is complete. The remaining task is to chart the data on cross-section paper, indicate the control limits, and observe the results. Exhibit 4 is graphic presentation of the $\overline{X}$, or average, data.

Control limits for $\overline{X}$	
$\overline{R}$	3.13
Factor A_2 for sample of 8 from table of factors	.37
$\overline{X}$	5.325
Upper control limit 5.325 + .37 × 3.13	6.48
Lower control limit 5.325 — .37 × 3.13	4.167
Control Limits for R	
Factor D_4 for sample size 8 from table of factors	1.86
Upper control limit 1.86 × 3.13	5.82
Factor D_3 for sample size 8 from table of factors	.14
Lower control limit .14 × 3.13	.438

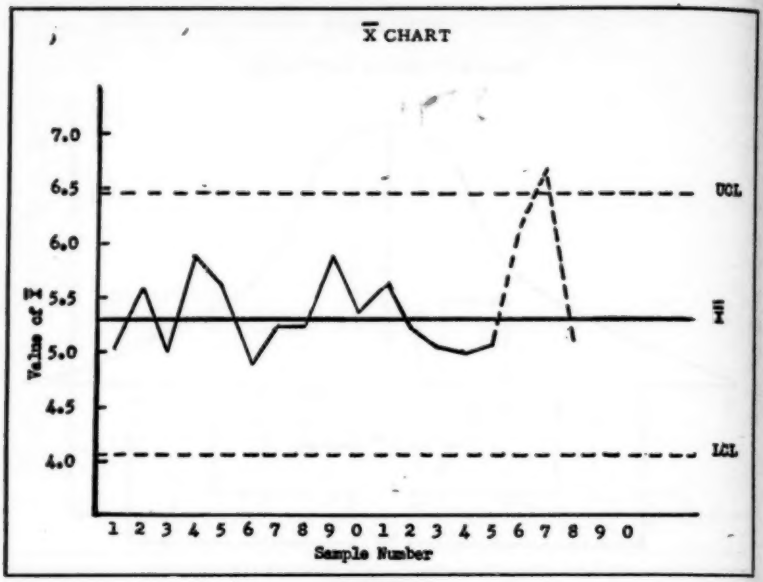

EXHIBIT 4

The horizontal scale represents the sample number and the vertical represents the values of $\bar{X}$. The calculated values for $\bar{X}$ developed in Exhibit 2 are plotted, as well as the calculated upper and lower control limits. Visual observation discloses that none of the observed measurements fall outside the control limits. Therefore, it can be concluded that, as far as the average is concerned, the operation is in control.

Now examine the R Chart. Exhibit 5 simplifies in chart form the data developed in the range column of Exhibit 1. Here again, the horizontal scale represents the sample number. The vertical scale represents the values of R. As in the $\bar{X}$ chart, the upper and lower control limits are drawn in. It can readily be seen that the observed ranges also fall within the control limits. Again, it can be concluded, that, as to range, the operation is in control, that is, the variability of the observed measurements is such that it could be due to normal deviations. It will be noted that no statement is made concerning the acceptability of the operation or procedure. All that has been done is to measure variations from a standard, determine when these variations become significant, and take appropriate action for their correction.

Following on to Improved Cost Control

At this point, we have several tables, a mass of impressive mathemati-

cal calculations, and two graphs. But just how do we use this material to assist in controlling costs? The procedure is quite simple. Take periodic samples or observations, every hour, once each day, or whatever period is decided upon as most advantageous and economical, taking care, however, to keep the subsequent observations on the same base as the initial data. After taking the observations, calculate the average and range for each sample and plot on the $\overline{X}$ and R charts. If these new points are within the control limits, then, apparently, no significant change has taken place. If they are out of control, investigate the causes.

Suppose that observations for samples 16, 17, and 18, obtained under the same sampling procedure as used in the collection of data in Exhibit 1, gave the following values:

Sample number	Observations Within the Sample								X Average	R Range
	1	2	3	4	5	6	7	8		
16	7	7	7	6	7	2	8	5	6.125	6
17	8	7	6	6	7	7	7	6	6.75	2
18	6	5	4	5	5	7	4	5	5.125	3

Now plot the averages and ranges on the respective charts. It will be noticed that, in sample 17, the average is out of control while, in Sample 16, the range is out of control.

Being practical about it, you ask, what does this mean? In the case of Sample 16, something happened which caused the range to spread from 2 to 8. Perhaps this does not seem to be very important, since the two periods more or less offset each other. True, but that is precisely where conventional cost analysis may fail. By the end of a week or month, this variation in range could never be detected. Look at it this way. This variation has certainly cost money at the point at which the process went up to a variation from standard to 8. Conversely, although it is a fact that the control limit is set at 5, there is a short period of operation at a variation from standard to 2. There is always the possibility that investigation along this line can bring to light methods, procedures, machine speeds, personal techniques, or other conditions which will permit reduction of the standard to something less than the currently acceptable five minutes.

In Sample 16 the average remains in control. It is only the range which indicates possible trouble. In Sample 17, however, there is an indication that the entire center has shifted. On the average it is just taking more time to perform this standard function. Why? Perhaps it is due to the weather or to the fact that this is the day before or after a holiday. Whatever the cause, corrective action can be taken. There is awareness of a significant shift in the average. Conventional analysis would fail to detect a shift in the average for a short period of time.

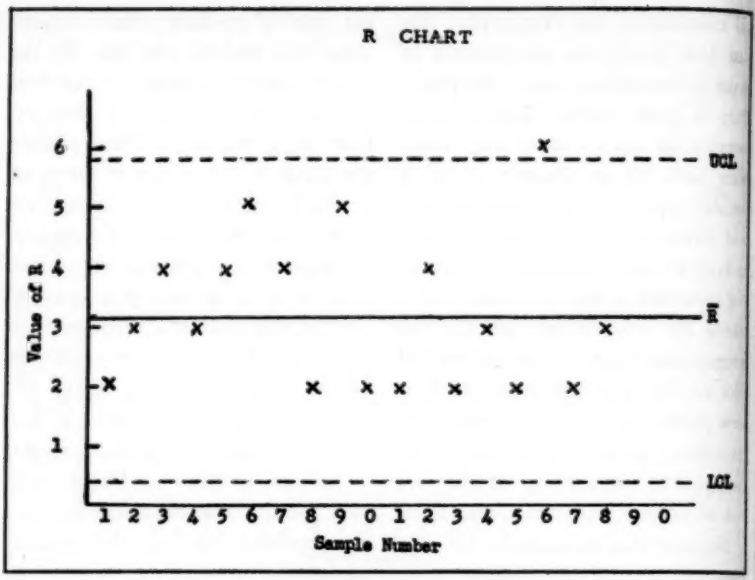

EXHIBIT 5

Applicability to Wide Ranges of Data—and of Companies

Over the years most industrial accountants have experienced some difficulty in making production people understand cost reports. Here is an opportunity to meet them on their own ground. Statistical quality control techniques are familiar working tools with them and facts presented on this basis will be readily understood. In the final analysis, they are the people who must do the real controlling. Cost analysis presents the facts. It highlights the existence of danger signals which indicate a need for improvement. If this tool is capable of doing a job better, there is little reason to neglect its use.

In the example given here, we chose a simple situation, standard time for a specific operation. However, the usefulness of this technique is not limited to situations involving direct labor. Any significant categories in direct or indirect costs are potential areas for its application. It can be applied either to individual or groups of homogeneous costs related to some common measurement of volume, production, or efficiency. Control of absenteeism, use of stationery and office supplies, incidence of maintenance costs, utilization of operating supplies, application of direct and indirect salaries and wages, and material usage are

but a few of the many critical cost situations which come to mind. Many others could be mentioned which might be of varying importance in any given organization. A careful review of the particular operation can bring to light the areas which will respond most readily to this treatment.

Since control charting is essentially a system of sampling rather than of accumulation of a great mass of accounting data, it is admirably suited to organizations desiring some degree of cost control without the attendant increase in overhead cost. It is less costly to take a periodic sample two or three or more times per month than to accumulate all data for a full month, balance it to a control account, and finally arrive at an answer—an answer which is assumed to be correct simply because it is mathematically accurate. It is this aspect of reduced effort in providing cost control, coupled with the characteristic of timeliness, that offers great potentialities in the use of control charts.

The material presented here is certainly not exhaustive. Much more could be said. The approach taken is relatively new to cost control. One can pretty much make one's own rules as one goes along, as long as one does not violate established statistical theory and practice. Perhaps some of the time devoted to conventional cost reporting might be diverted to better advantage on a program such as this. The reports are not quite as attractive and will not necessarily balance out, but they do tend to reveal vulnerable cost situations.

Calculating Control Limits for Cost Control Data

by CARL E. NOBLE

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Relying to some extent upon concepts set forth in the author's earlier paper("Cost Accounting Potentials of Statistical Methods," N.A.C.A. Bulletin, *August 1952) and in the article which precedes the present one in this issue ("Use of Control Charts in Cost Control"* by Edwin W. Gaynor), *there are offered here two instances in which variances from standard are charted in terms of average of variances* ($\overline{X}$) *and range of variances (R). The charts are reproduced and their control uses explained.*

THE COST ACCOUNTANT is frequently required to answer the question, "How large a variance from standard should be tolerated before considering the variance abnormal?" Variations in cost measurements are expected, even though the factors contributing to these measurements re-

main unchanged for all practical purposes. The actual measurements are only samples of the basic process producing them. Yet, the standard cost control system fails to furnish an objective technique for dealing with this inherent process variation. It considers an operation satisfactory or unsatisfactory when an actual cost falls to one side or the other of a standard. Occasionally the standard is set in such a manner that a favorable variance is expected and an unfavorable variance indicates that the process is subnormal. Thus, an unfavorable variance is agreed to be a realistic sign for action. This procedure is objectionable on at least three counts: (1) the standard is no longer a measure of expected cost, (2) the deviation of the standard from expected cost is determined largely upon subjective judgment, and (3) the periods during which the operation is better than usual go unnoticed.

This paper recommends that the standard coincide with the expected cost and presents objective methods of calculating control limits for the variances from standard. Past data on established operations usually furnish reliable bases for estimating expected costs and calculating control limits. These control limits serve to flag good as well as poor periods of operation. The importance of investigating a process when the costs are significantly better than standard has been overlooked too long. The discovery of the causes for the improved operations often leads the way to permanent cost reductions.

Charts for Control of Rate of Carton Production

One method of calculating control limits may be explained with an example involving a machine for converting paperboard into breakfast food cartons. The variance of the actual number of cartons from standard is recorded to the nearest gross for each two hours of operation during the eight-hour working day. Exhibit 1 tabulates the variances for the four two-hour periods during twenty consecutive days. The $\overline{X}$ and R columns show, respectively, the arithmetic mean and the range of four measurements for each day. The problem is to find the control limits for the $\overline{X}$ and R values plotted on their respective control charts in Exhibit 2.

In calculating these limits, the average $\overline{\overline{X}}$ of the $\overline{X}$'s and the average $\overline{R}$ of the R's are first found:

$$\overline{\overline{X}} = \frac{0.4}{-20} = -0.02, \text{ and } \overline{R} = \frac{290}{20} = 14.5.$$

Since it has been assumed that the standard coincides with the expected production level, zero is taken as the center line on the $\overline{X}$ control chart. (If this assumption is incorrect, then one would probably use $\overline{\overline{X}}$ as the center

line.) Using zero as the center line, the control limits for the $\bar{X}$ chart are:

$$O \pm A_2\bar{R}, \text{ or } O \pm (0.729)\ (14.5) \text{ or } \pm 10.57,$$

where A_2 depends upon the number of measurements contributing to each $\bar{X}$ (four in this case) and may be found by reference to *American War Standard—Control Chart Method of Controlling Quality During Production,* Z1.3-1942, published by American Standards Association, New York, N. Y. The factors D_3, D_4, and d_2 introduced below are also given in this reference.

The center line on the R chart is $\bar{R}$ and the control limits for this chart are:

$$D_3\bar{R} = (0)\ (14.5) = O \text{ and } D_4\bar{R} = (2.114)\ (14.5) = 30.65.$$

It may be observed that, in Exhibit 2, all the points in the R chart are within the control limits but that three of the first four points on the $\bar{X}$ chart are outside these limits. One would suspect that the process was abnormal during the first four days. If investigation reveals that this was true, then all the data for these four days are deleted and new control limits calculated for the remaining sixteen days. The following values of $\bar{X}$ and $\bar{R}$ are then obtained:

$$\bar{X} = \frac{2.7}{16} = 0.17, \quad \bar{R} = \frac{205}{16} = 12.81.$$

The new control limits are:

$$O \pm (0.729)\ (12.81) = \pm 9.34 \text{ for } \bar{X}, \text{ and}$$
$$D_3\bar{R} = (0)\ (12.81) = O \text{ and } D_4\bar{R} = (2.114)\ (12.81) = 27.09 \text{ for R.}$$

Since all of the last sixteen points on both the $\bar{X}$ and R control charts fall within their respective limits, it is reasonable to assume that these limits are reliable. Hence, they are projected on the chart to serve as limits for further control of carton production. After additional data have been collected for a month or more, these data should be combined with those in Exhibit 1 and new control limits calculated for the $\bar{X}$ and R control charts. The procedure of removing data taken while the process is abnormal is called rationalization of the data.

Usually, in applications such as this, the total variance for the eight-hour day is plotted, rather than the average variance for two-hour periods. If the total daily variance, $4\bar{X}$, is plotted in Exhibit 2, then the control limits are multiplied by 4. They are:

$$\pm 4\ (9.34) \text{ or } \pm 37.36.$$

The control limits described here are called three-standard-deviation or three-sigma (3σ) control limits If the factors contributing to the production of breakfast food cartons remain constant, then, theoretically, one would expect $\bar{X}$ or an R to fall outside the 3σ control limits approximately 3 times in 1000, on the average. The terms A_2, D_3, and D_4 are derived in

VARIANCES FROM STANDARD IN NUMBER OF BOXES PRODUCED DURING TWO-HOUR PERIODS

		TWO-HOUR PERIODS					
		I	II	III	IV	X	R
	1	— 5	5	14	—14	0	28
	2	16	24	12	7	14.0	17
	3	—15	— 2	—29	— 6	—13.0	27
	4	—16	—17	— 4	—12	—12.3	13
	5	10	13	3	4	7.5	10
D	6	0	—15	— 6	— 7	— 7.0	15
a							
y	7	—10	— 4	— 2	7	— 2.3	17
s							
	8	12	11	— 5	— 4	3.5	17
	9	4	8	—19	—14	— 5.3	27
	10	— 1	1	— 7	— 5	— 3.0	8
	11	— 4	— 9	8	1	— 1.0	17
	12	4	14	8	3	7.3	11
	13	— 1	— 6	3	— 2	— 1.5	9
	14	1	5	— 6	6	1.5	12
	15	0	3	5	— 2	1.5	7
	16	— 9	1	— 1	— 2	— 2.7	10
	17	2	5	3	— 2	2.0	7
	18	6	6	4	— 3	3.3	9
	19	7	— 2	10	0	3.7	12
	20	10	10	— 7	— 2	2.7	17

EXHIBIT 1

such a manner that they give 3σ limits when applied as described above. Most elementary textbooks on statistics explain the theoretical significance of σ units. In actual practice the probability of a point falling outside the 3σ control limits may sometimes be closer to 1 in 100 than 3 in 1000. The cost accountant will often find 2σ control limits more practical than the

3σ ones. The 2σ limits for the X chart in Exhibit 2 are:

$$\begin{matrix}+2\\-3\end{matrix} \quad (9.34) \text{ or } \pm 6.23$$

For a controlled process, the theoretical probability of a point falling outside its 2σ control limits is 0.05. A controlled process is one in which all the factors contributing to the process are relatively constant and the variation in the measurements emanating from the process is due only to chance causes. This chance variation either cannot be reduced or cannot be reduced profitably. As long as the $\overline{X}$ and R values fall within the control limits, the process is assumed to be in control. Since the probability is small that a point will fall outside the control limits from chance causes alone, the assumption that control exists is rejected when such an event occurs. Action is then taken to bring the process back to normal.

Chart for Control of Labor Variance

The control of labor variance supplies an example of another common procedure for calculating control limits. It is preferable to secure a number of cost or production measurements during a day (or a shift) and base the limits for day-to-day control upon the variation in these within-day measurements. However, in some cases, it is practical to obtain measurements only at the end of a day. Such is the situation for labor variance in a given department. The variance in hours of the actual labor from standard is given for twenty-five days in Exhibit 3.

The first step in calculating control limits for these daily measurements is to find the absolute differences R between the consecutive variances. These differences or ranges are lisited in Exhibit 3. The next step is to find the average of the ranges:

$$\overline{R} = \frac{482}{24} = 20.08$$

The control limits for the R's are calculated in order to measure the degree of control among them. The limits are:

$$D_3\overline{R} = (0)\ (20.08) = 0 \text{ and}$$
$$D_4\overline{R} = (3.268)\ (20.08) = 65.63,$$

where D_3 and D_4 are based upon a sample of size 2, the number of measurements contributing to each R. It may be observed that all R's lie inside these control limits. In fact, only one R falls outside the 2σ limits, which are

$$0, \text{ and } (2.512)\ (20.08) \text{ or } 50.45.$$

Thus, one may assume that the R's are in good control and that $\overline{R}$ can be used to calculate the standard deviation σ for the daily variances X:

$$\sigma = \frac{\overline{R}}{d_2} = \frac{20.08}{1.128} = 17.80,$$

Assuming the standard variance to be 0, the 2σ control limits for X are

$$0 \pm 2\ (17.80) \text{ or } \pm 35.6,$$

and the 3σ control limits are

$$0 \pm 3\ (17.80) \text{ or } \pm 53.4.$$

The occurrence of one point outside

CONTROL CHARTS FOR VARIANCES IN PRODUCTION OF CARTONS

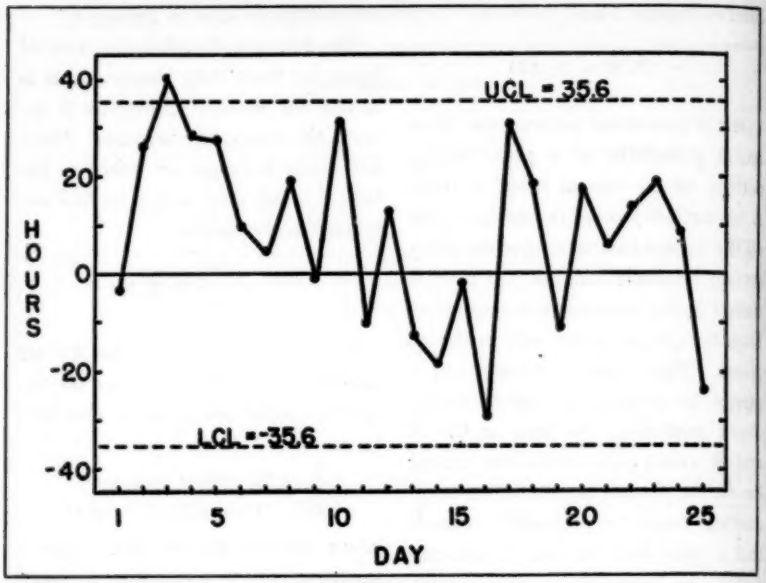

EXHIBIT 2

the 2σ control limits in Exhibit 4 should not be disturbing. Approximately one in twenty points are expected to be outside the 2σ limits on the average.

The spread of the control limits, with this method, depends upon the variation between the daily variances. It is assumed that the range between consecutive daily variances is dependent only upon chance causes. However, these ranges obviously are due, to some extent, to real differences in the operation between days. Hence, the ranges tend to be larger and, in turn, the control limits wider, than would result from chance causes alone. For this reason, 2σ limits are usually preferred when the control limits are based upon ranges of consecutive daily measurements.

Because real differences in the day-to-day operations are likely to inflate certain ranges of the consecutive daily variances, it is important that a careful job of rationalization be done. Rationalization is applied to remove unusually large R values occurring because of day-to-day changes in the basic cause system. The steps in rationalization involve the calculation of D_4R and the removal of all R values

VARIANCES FROM STANDARD HOURS OF DAILY LABOR

DAYS	X	R	DAYS	X	R
1	— 4		14	—18	
		30			16
2	26		15	— 2	
		14			27
3	40		16	–29	
		12			61
4	28		17	32	
		1			13
5	27		18	19	
		17			30
6	10		19	—11	
		5			28
7	5		20	17	
		14			11
8	19		21	6	
		20			8
9	— 1		22	14	
		32			5
10	31		23	19	
		41			10
11	—10		24	9	
		23			33
12	13		25	—24	
		26			
13	—13				
		5			

EXHIBIT 3

above this limit. A new $\bar{R}$ is then calculated from the remaining R's. These steps are repeated until all values of R are less than $D_4\bar{R}$. If many R's have to be removed in the rationalization process, it is an indication that the

CONTROL CHART FOR DAILY LABOR VARIANCE

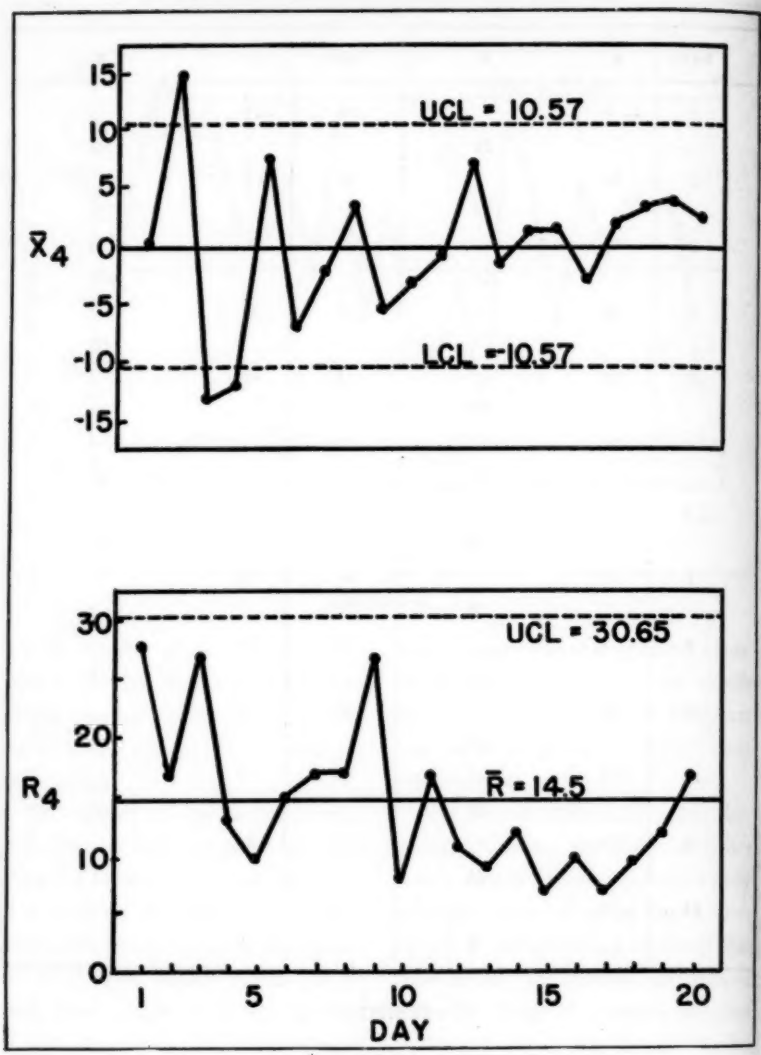

EXHIBIT 4

basic cause system is varying from day to day, and the data probably are not altogether reliable for setting limits for future control.

Applications of the Control Limits to Cost Control

The common methods of calculating control limits have been described. How, then, do they fit into cost accounting procedure? One application is in the field of presenting cost information to various levels of management. It is usually impractical to plot the voluminous monthly (and weekly) cost data on control charts. Nevertheless, the significant monthly cost deviations should be highlighted. This can be done by first calculating the control limits for the monthly variances. Each variance is then listed on the monthly report in, say, red, black, or green—depending upon whether it is above the upper control limit, within the control limits, or below the lower control limit. Such a procedure is a valuable aid in interpreting the monthly cost data. All too often management spends time, money, and argument in search of the cause of a variance which may be attributed to chance causes alone.

As an aid to the control of costs on an hourly and daily basis, the control limits through the control chart play a most important role. Even though the monthly report is an integral part of most control systems, it is of limited value from the control standpoint. There is too much delay in waiting for such a report to indicate unfavorable costs. Also, the monthly variance frequently represents the results of a heterogeneous set of operations and may actually typify none of them. It is difficult to locate the causes of abnormal costs and place responsibility for them. The control charts correct this difficulty by letting the points on the charts represent homogeneous operating units. This chart places before the operator a picture of the cost factors over which he has control, in units he understands, and at a time when he is able to correct poor operations. Each point of the chart represents the work of one man or one crew.

There are too many activities in industry today in which the operator is completely unaware of his achievements. How many men would continue to bowl for their health if a curtain were dropped as they released the ball? Everyone is interested in knowing his score in every activity in which he engages. Hence, it is not surprising to observe the many examples in which the operator's interest and productivity have been increased when his cost (and quality) achievements are displayed on control charts.

THE COST FORUM

PRODUCT DISCONTINUANCE DECISIONS

Editor, N.A.C.A. Bulletin:

MUCH HAS BEEN WRITTEN and said regarding the costing of products which are to be introduced to make use of idle capacity or which may be obtained as by-products. Various methods used to derive sales prices for such items have been reviewed many times. Most often, prices are based primarily on cost. However, when the job is done properly, direct and allocated investment necessary to manufacture the products and the return thereon must be considered. The decision to produce and sell such products is but the beginning. Periodically (at least annually) earnings from, not only these but other company products also, should be analyzed to determine whether or not anticipated earnings and return on investment are being realized.

Frequently, when studying product earnings, it is deemed sufficient to relate costs and selling prices and, if the profit percentage is more or less adequate, the situation is considered as being satisfactory. The analysis should go much further. Earnings of each product should be related to direct and allocated investment which attaches itself to the various products, and a return on investment should be computed. Various returns being realized should be compared and a standard, perhaps 10 per cent to 15 per cent net return on total investment in each product, be set as normal. Products earning less than the established minimum should be subjected to further review, with the idea of their possible elimination so that more effort can be directed to higher profit earners.

The analysis of whether or not to continue selling a particular product should be a more detailed one than simply computation of the investment return being made or the profit percentage being secured. Just as when a study is being made as to the profitability of introducing products which will make use of idle capacity or which can be obtained as by-products, it is necessary to think of incremental costs and give special consideration to these same factors when discontinuance of any losing or low-earner product is being evaluated.

Loss of earnings is the important item in formulating a decision to discontinue a product yielding in unsatisfactory return on investment. If the product is not already losing money, any earnings being realized will disappear completely. Therefore, unless some other product is substituted, the firm will suffer a financial loss. If, however, the investment can be used elsewhere to bring about greater earnings than those lost, total earnings of the firm will be increased. A helpful procedure in the determination of total loss of earnings and in determining also the investment which will be released because of product is discontinued, is outlined below. This computation will indicate the return which must be exceeded, using the recoverable investment, if earnings are to be augmented.

To average earnings being realized by the product under consideration must be added any allowances for depreciation and obsolescence included in its cost, as well as any irreducible items of overhead which will have to be reallocated to other products. This will then be total expected loss

of earnings. From the expected loss of earnings must be subtracted taxes currently being paid, such as Federal income tax, to arrive at the net loss of earnings figure. The net loss of earnings will then be related to investment recoverable, to determine the return figure to be used in making the discontinuance decision.

Recoverable capital consists of working capital, realizable value of direct investment, value of allocated facilities and additional foreseeable investment. A factor often ignored, but nevertheless quite important in computing recoverable capital, is that dealing with reduction in certain reserves such as those established for various retirement plans and separation wage payments oftentimes given. Reduction of reserves will increase recoverable investment, whereas any wage payments will reduce capital to be made available. Once net recoverable capital has been so determined, it is related to true net loss of operative earnings, to arrive at the return on investment to be used in deciding whether a product should be discontinued, and whether or not the capital which can be made available might be more profitably employed elsewhere.

It is, of course, recognized that the above explanation simplifies the situation. It deals with tangible financial factors only, whereas, any final decision must necessarily include intangible considerations which can be of greater importance than figures.

GEORGE W. FRANK, *Philadelphia Chapter*

INTEGRATED DATA PROCESSING AND COMMON LANGUAGE OFFICE MACHINES

Editor, N.A.C.A. Bulletin:

IT IS MOST ENCOURAGING that concerns like United States Steel, together with office equipment manufacturers, have been searching for a solution to our current and future data processing problems. Their answer is integrated data processing. Modern business demands that many levels of management receive an ever increasing amount of information. The time provided to process this data is being constantly reduced. Each new demand results in increased office costs unless new techniques are developed to process more data and provide more information at the same or reduced cost.

For many years, accountants, office managers and methods personnel have utilized various techniques and machines to simplify, combine, eliminate, expedite and improve office operations. These methods range from simple systems based on carbon paper to bookkeeping machine systems, punched card systems, reproduction systems, to electronic devices. However, the job is not complete. Today, most business procedures require humans to act as the translating link between various pieces of office machinery. Data recorded by typewriters has to be copied to be indexed on a bookkeeping machine or key punched into a tabulating card. Information provided by adding machines, desk calculators, etc., must be copied to be typed on the desired document. Independent office machinery requires manual operations to enter repetitive data.

For this reason, there is little hope that independent units of office machinery can continue to solve many of the problems to be faced by the office of today or tomorrow. Integration of office procedures, so that data can be made self-perpetuating from the original operation through all subsequent processes, is now required. It is a system that offers a potential equal to that originally presented by carbon paper and the first typewriters, adding machines, etc. Integrated data processing is a logical forerunner to the maximum use of electronic

office devices. The concept of integrated data processing is to utilize a common language medium — the five-channel code punched paper tape—to mechanically process data through many types of office machines. Original data is recorded at the point of origin on machines which create punched paper tapes or cards, and then is processed, along with additional data, on machines which read and punch tapes. The five-channel punched paper tape was selected as common language medium because it is used in the communication field and because communication is an important factor in most office and administrative operations.

The common language of integrated data processing as defined by Mr. H. F. van Gorder of the United States Steel Corporation is: "A recording medium that: (a) comprehends the twenty-six letters of the alphabet, the ten decimal digits and a minimum of special characters and functions (b) has the ability to directly mechanize the transfer of raw data between office and communication machines manufactured by different suppliers." The common language medium may be a continuous paper tape or a unit card containing the five-channel punched code. The common language can be directly read and/or punched by many types of office equipment and can be mechanically converted to a medium (such as tabulating cards or magnetic tape) that other machines will understand and process.

Visualize an integrated sales procedure which mechanically perpetuates data through the following functions: Sales order and acknowledgment preparation, production scheduling and control, inventory control, shipping document preparation, invoice preparation, accounts receivable and sales statistics. What would it mean to a company if data created at some point in this complex process could be mechanically processed through all subsequent operations? Manual copying operations with the resulting proof procedures, are eliminated. Much of the information used to perform the above functions is the same. Common language office machines can process this information through all functions, at speeds and accuracy in excess of what can be obtained on office machines manually operated by humans.

Present common-language office machines are not basically new, except that some of them, for the first time, will now interpret and/or create the common language medium. Communication equipment, such as teletype and telegraph, have used punched paper tape for years. There are typewriters, addressing equipment, and tape-to-card and card-to-tape converters on the market now which will read and/or punch the common language medium. Common language adding machines, desk calculators, bookkeeping machines, etc., will be available in the near future.

Integrated data processing has been described as "integrating the office for electronics." However, it is probably more than just a temporary solution. It may be a complete, perhaps final, answer to the data-processing problems faced by many companies today. Integrated data processing, common language machines, and punched paper tape are new and significant terms which are here to stay, as additions to the terminology of the office workers.

ROBERT A. RIETZ, *Milwaukee Chapter*

OBTAINING RELIABLE MATERIALS-HANDLING COSTS

Editor, N.A.C.A. Bulletin:

ONE OF THE MORE SERIOUS PROBLEMS confronting the cost accountant and one which is growing in complexity is the problem of determining materials-handling

costs. Although the cost accountant may be well equipped for determining labor costs through the use of many payroll devices and for identifying overhead expense by means of elaborate budgets, there is only a slight possibility that his systems offer any concrete information on costs of handling materials. The cost accountant's inability to reflect properly the effect of materials-handling charges has been a topic of discussion and a subject of many articles by authorities associated with the Materials-Handling Society.

The author of one such article criticized present reporting of materials-handling costs by accountants and cautioned readers to approach operating figures compiled by an accounting department "as carefully as you would approach a mad dog or a rattle snake." Such a lack of confidence may seem shocking to the accountant but, nevertheless, the author of them felt he was justified in making the statement. He had found that the materials-handling cost figures he received varied widely depending on the accounting concepts used. It was the old story of figures carried to four decimal places but containing elements of costs arbitrarily determined and arbitrarily prorated. Similar opinions are shared by many materials-handling personnel.

The job of rendering this opinion unjustified should represent a challenge to every accountant. I believe it can be done through the following measures:

1. Convince the skeptics that good accounting systems do contain the information needed for determining materials-handling costs. If this information is not compiled as a normal function and may be buried in overhead expense figures, it is possible to extract important facts necessary to the determination.
2. Overhaul labor reporting systems to classify all labor connected with the moving, handling, or storing of materials. If accounting practice treats material-handling as overhead, be certain that every important element of this phase of cost can be segregated and identified by operation.
3. Expand the chart of accounts to accommodate and identify materials-handling costs. This includes establishing separate accounts for depreciation of materials-handling equipment, repair and maintenance of such equipment, and maintenance of storeroom and shipping and receiving departments.
4. Work closely with materials-handling personnel when evaluating accounting data to be adapted to theories advanced by this group. Because of the rapid strides being made in the handling, moving, and storing of materials, it is entirely possible that the accountant may have to be educated to the concepts being developed and passed along by experts in the materials-handling field.
5. Report materials-handling costs in measures which make them of the greatest personal interest to the individuals receiving the information. Costs can be related to number of employees, ratio to finished product, per unit of finished product, per hour cost, area cost, displacement size, etc.
6. Recognize the importance of materials-handling and the possibilities it offers in cost savings.

Experience and analysis has enabled the accountant to furnish acceptable and accurate cost information on all other phases of the industrial operation. With the proper application of the foregoing points, materials-handling costs will present no exception.

FRANK J. WAGNER, *Muskegon Chapter*

OIL PRODUCTION ILLUSTRATES PLACE OF INCOME TAX AS A COST

Editor, N.A.C.A. Bulletin:

THERE ARE SOME ACCOUNTANTS and many economists who will argue that income tax should not be considered in making "pay out" calculations for corporate enterprises, because income tax represents a division of profits to the Government, similar to the devision of profits represented by

dividends to stockholders. I believe this theory to be unsound, as income taxes are a cost of doing business which must be provided for by corporations in much the same way as with any other cost. Although income taxes are a proportion of net taxable income, it is misleading to hold that this expense is comparable to distributions to stockholders simply because the amount of it is determined by reference to net income. This is particularly evident when we consider the wide variation which exists between the statutory net income for income tax purposes of oil and gas companies and their book net income which is available for payment of taxes and dividends and retention in the business.

The principal benefit to be obtained in using income tax as a cost factor in "pay out" statements lies in evaluation of the relative merits of capital expenditure projects to determine:

1. Should the money be spent at all?
2. Should it be spent in the proposed way?
3. When should it be spent?

Since all corporate budgets must be prepared with consideration to maintaining a reasonable, normal balance between funds available for investment in the business and funds available for dividends to the stockholders, "pay out" statements are commonly used to weigh the relative importance of capital projects which may be proposed. (Certain projects are operating necessities, such as repairs required to maintain production. With this type of project we are not concerned, as in such cases the "pay out" statement, itself, is largely of academic interest.) Application of the income tax factor frequently produces a startling change in the apparent relative merits of projects which are being compared. The effect of the income tax factor increases as the tax rates increase and reaches a peak in periods of excess profit taxes.

In the oil and gas business, the activity of drilling development wells generally will have a faster "pay out" after taxes than any other type of capital expenditure. This is due to the tax credit in the first year resulting from deduction of intangible development costs, and the subsequent deduction for percentage depletion. The petroleum industry has drilled many development wells which might never have been drilled had the income tax credit for the intangible costs not been considered in the "pay out" calculation. These include many marginal wells which would have shown a doubtful "pay out" without consideration of the tax saving.

Use of income tax as a cost factor in "pay out" calculations in connection with development drilling programs is also of assistance in planning the drilling program to result in the minimum possible percentage depletion loss arising from application of the fifty per cent net income limitation. This can be demonstrated by a simple illustration.

Operator A has a proven tract of 160 acres on which one well has been drilled during the year, with three more undrilled locations. By drilling the three remaining locations in the current year, Operator A is able to get the full benefit of percentage depletion in the second year. If he were to drill only one more well in the current year and postpone two wells until the following year, it might be foreseen that his property would have a negative net income and consequently no percentage depletion in either year.

Consideration of the tax factor has also enhanced the "pay out" attractiveness of facilities constructed under certificates of necessity. In planning the original design of processing and refining plants, some-

times it was found to be desirable to consider the possibility of obtaining a necessity certificate with a high percentage of certification. For example, a natural gasoline plant capable of manufacturing liquefied petroleum gas mixtures and natural gasoline probably would not have received as favorable certification as a more versatile plant capable of producing blending stocks for use in the manufacture of high octane aviation gasoline. With some additional expenditures the former plant might have been constructed to produce blending stocks which would sell for a higher price, as well as qualify the plant for higher certification.

On the other side of the picture, introduction of income tax as a cost factor in "pay out" calculations tends to place in a less favorable light the "pay out" of such projects as uncertified refinery units, pipe lines, bulk plants, and service stations. Such projects must bear the full burden of tax on the net income which they contribute to the corporation, without the benefit of substantial statutory deductions in the early years of their life.

The income tax position of the corporation is likewise an important factor to be considered in determining the over-all magnitude of the exploration program to be undertaken. Before deciding what amount is to be budgeted for exploration, it is necessary to have an estimate in total of the tax effect of proposed exploration expenditures. However, due to the uncertainties of success or failure, it is not practical to make reliable "pay out" calculations for individual exploratory projects.

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